Pellagra

The Plague that Decimated the Poor of the Southern United States

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Preface

Pellagra was first described in Southern Europe in the 16th century, but it did not appear in the United States until the turn of the 20th century. It then ravaged the Southern United States and was not eliminated until the 1940’s. Pellagra was a disease of the “Four Ds”: dermatitis, diarrhea, dementia and death. Although pellagra is now forgotten in the United States, it still occurs in some parts of the world; particularly in China, Indonesia and Africa. Pellagra is due to a severe dietary deficiency of niacin (vitamin B-3) and its key metabolic precursor tryptophan. But the deficiency itself was caused by the desperate socioeconomic conditions of Southern Europe and the post-reconstruction Southern United States.

This review will begin by limning the lives of the principal characters mentioned in the book, then quote the original description of pellagra by Gaspar Casal, tell the story of the introduction of corn (maize) into the Old World with its ramifications and the advance and decline of pellagra in Spain and Italy. Then I will describe and illustrate the clinical disease, its medical signs and symptoms particularly as they relate to the skin and the various theories advanced for the cause of pellagra in the United States. Then, the rise of the cotton mills of the South, the incidence of pellagra over time, the suffering and death incurred, and the battle to conquer it, particularly by Goldberger and his team will be traced. The city of Spartanburg, South Carolina will be discussed in detail primarily because the two principal United States teams that investigated pellagra were headquartered there.

Many excellent articles and books have been published about pellagra in the past hundred years. We have referenced them exhaustively. Why should another lengthy story of pellagra be written? Because most of the articles and books have concentrated on one, or a few facets of the history of pellagra and because some have ignored pellagra in Europe. Most have concentrated on Joseph Goldberger and his quests in the United States. They have discussed pellagra’s predominance in mental institutions, orphanages, prisons and mills in the South, but many have not stressed and reported on the miserable pay and living conditions of the mill workers with the resulting labor unrest and failed strikes.
Difficult problems confront one who tries to write the history of pellagra in the United States because the war against this plague that attacked and killed so many people lasted but three decades, because of the denial that the disease existed in particular localities (pellagrophobia), the denial that socio-economic factors were involved, the conflicting statistics, the battles over the various theories of the immediate cause of the disease and—yes—the egos of those involved in the study of pellagra.
Gaspar Casal, who first described pellagra, was born in either 1679 or 1680. The exact place of his birth in Spain is unknown. The first years of his life were spent in Utrillas, a small town in the province of Soria, in Northern Spain, the birthplace of his mother. Evidence indicates that he learned medicine in the village of Atienza, Guadalajara by apprenticeship to Juan Manuel Rodriguez de Lima, a former apothecary to Pope Innocent XI or perhaps in the University of Siguenza where Casal received the Bachelor of Arts degree in 1713. In 1707, he began the practice of medicine in various towns in the region of La Alcarria, particularly in Atienza.

He left the province of Guadalajara and practiced medicine in Madrid. For reasons of health, Casal left Madrid in 1717 and established his medical practice in Oviedo, Asturias. He became the city’s official doctor and the chief of staff of the hospitals there. Over time, his reputation increased and he became known as the Asturian Hippocrates and then, when patients came far and wide to consult him, he was called the Spanish Hippocrates.

In 1751, after practicing more than thirty years in Oviedo, he returned to Madrid and was appointed physician to King Ferdinand and a member of the Royal Academy of Medicine. He died on August 10, 1759 at the age of 80 and is buried in Madrid.\textsuperscript{1,2}
Stewart Ralph Roberts, M.D. (1878 -1941)

Stewart Ralph Roberts was born in Oxford, Georgia, on October 2, 1878. His great grandfather was one of the original contributors to the establishment of Emory College and his father was a trustee of the school. In 1894, Stewart Roberts entered Emory College at Oxford. After two years of college work he decided to begin the study of medicine at the Southern Medical College. He graduated in 1900 and returned to Emory College in the fall of 1900, and finished his academic courses, graduating in 1901 with a B.S. degree.

He undertook further study at the University of Chicago then returned to Emory College where he accepted the professorship of Physiology at his Alma Mater. After teaching physiology at the Atlanta College of Physicians and Surgeons for several years, this school combined with the Atlanta School of Medicine and became the Medical Department of Emory University. In this reorganization, he was made Professor of Clinical Medicine.

He contributed to many medical journals and his one book on Pellagra received a great deal of attention. He was president of the Fulton County Medical Society, the Southern Medical Association and the American Heart Association. During World War I, he was a Lieutenant-Colonel in command of the Base Hospital at Camp Jackson, Columbia South Carolina. He died on April 14, 1941. He was survived by his wife, the former Miss Ruby Holbrook and three sons.³
His work on pellagra accounts for our interest here. In 1911, Roberts spent months in Europe where he visited Spain and Italy, met with physicians who were interested in pellagra, and studied the disease at the various hospitals for pellagrins (pellagrosarios). Roberts compiled statistics on pellagra in Southern Europe, as well as the United States. We quote his book, *Pellagra: History, Distribution, Diagnosis, Prognosis, Treatment, Etiology* published in 1912 extensively, particularly his statistics and clinical descriptions of pellagra. The latter are valuable because they are not available now with the disappearance of the disease. His comments on the pathology and histopathology of the disease are difficult to interpret today.
James Woods Babcock, M.D. (1856-1922)

James Woods Babcock was born in Chester, South Carolina in 1856. After earning a medical degree from Harvard University, Babcock served as assistant physician at McLean Asylum in Somerville, Maine. In 1891, South Carolina’s Governor, Benjamin R. Tillman, appointed him Superintendent of the South Carolina Lunatic Asylum. Through Dr. Babcock’s leadership, the state hospital established the first training school for nurses south of Maryland. He not only was one of the first to study pellagra in the United States, but also was the first physician to call attention to the enormous death rate from tuberculosis among patients in institutions for people with mental illnesses. In 1908, Dr. Babcock, who was then the superintendent of the State Hospital for the Insane in Columbia, South Carolina, realized that patients in that hospital were dying of a new disease which he had not seen before. Because of earlier reports of the outbreaks of pellagra in mental hospitals, he diagnosed the new disease as pellagra and reported it to the American Journal of Insanity. The new disease rapidly increased in frequency, and it began to be recognized in inmates of prisons, orphanages, and in the general population.

During the summer of 1908, Babcock toured Europe with the new U.S. Senator for South Carolina, Benjamin R. Tillman. Troubled by the cases
of pellagra in Columbia, they visited several hospitals for pellagrins in Italy. Tillman, horrified by what he saw, asked the U.S. Vice-Consul in Milan to prepare a report of the epidemic of pellagra. Babcock was convinced that “Italian pellagra” was similar to the cases of pellagra in the American South.

Back in South Carolina, the State Board of Health became concerned about the spread of the epidemic of pellagra. Influenced by Babcock and Senator Tillman, Governor Marin Ansell called interested people together for a conference on pellagra in Columbia on December 9, 1908. Seventy-two physicians attended, most of them from within the state.

Both the Governor and Senator Tillman spoke at the meeting, lavishly praising Babcock for identifying the disease and calling attention to the developing epidemic. The meeting, later known as the first National Conference on Pellagra, led to press reports of the spread of the disease, which aroused great alarm and the beginning of the “pellagra scare.” A second National Conference of Pellagra was held in Columbia on November 3, 1909. The physicians who attended reported outbreaks of the disease in many parts of the country, especially in orphanages, mental hospitals and prisons. The National Association for the Study of Pellagra was formed and Babcock was elected first president. The conference recognized Babcock as “the father of the movement for the study and control of pellagra in America.” The Association met again in 1912 and 1915.

Although praised for his pioneering work on pellagra, Babcock resigned in 1914 from the State Hospital for the Insane. He was accused of having brought injury to the reputation and progress of South Carolina by calling attention to the prevalence of pellagra in the state. The investigation exonerated Babcock completely of any wrongdoing. Whether or not he was forced to resign his post at the State Hospital or did so voluntarily is not clear. Dr. Babcock then established and operated the Waverly Sanitarium in Columbia, South Carolina. Waverly performed a needed function by relieving some of the patient load from the State Hospital and served as a place where people with acute psychoses could find haven for short periods. From 1915 until his death in 1922, he also served as professor of mental diseases at the South Carolina College in Charleston.4,5
Joseph Goldberger (1874-1929)

Joseph Goldberger, who contributed extensively to our understanding of the cause of pellagra, was born in Austria in 1874 and immigrated with his parents to the United States in the 1880’s. He grew up in New York City and entered the College of New York as a high school graduate in 1890 to study engineering, but changed his field to medicine two years later by enrolling at the Bellevue Hospital Medical Center. He obtained his M.D. degree in 1895 and, after interning for one year, practiced medicine in New York and Pennsylvania for three years. However, he became bored with the practice of medicine and, together with encountering economic difficulties, he joined the U.S. Public Health Service in 1899.

He served as a quarantine officer in various ports including: New Orleans, Tampico, Veracruz and Havana. He studied and fought typhoid fever in Washington, D.C., studied yellow fever and typhus in Mexico, studied diphtheria in Detroit, among other epidemics, as well as investigated the health of the immigrants on Ellis Island. During his career he contracted typhus, yellow fever and dengue fever while studying these diseases. In 1909, he solved the cause of Schamberg’s disease, a pigmented dermatitis prevalent in crew members of private yachts and in men living in private dwellings and boarding houses in the Philadelphia area. Goldberger
and Schamberg observed that these men slept on straw mattresses, and they finally identified a mite (*Pediculosis ventricosus*) as the vector of the disease. Thus, Goldberger had considerable experience in epidemiology and knowledge of infectious disease when he was assigned by the Surgeon General to undertake the search for the cause of pellagra.

In February 1914, Surgeon General Rupert Blue asked Dr. Goldberger to take over pellagra studies in the South. In 1914, pellagra was wildly epidemic in the southern United States. South Carolina reported 30,000 cases in 1912 with a fatality rate of 40%. In 1914, Goldberger estimated that there were at least 50,000 cases in the South with 11,000 in the state of Mississippi alone. It should be pointed out that Goldberger became convinced that pellagra was due to a faulty diet, which he learned by reading the literature on the subject before he began his investigations.

At the time, pellagra was thought by many to be an infectious disease. Goldberger and his associates traveled throughout Georgia, South Carolina and other southern states observing employees in hospitals, asylums and orphanages. They noted that the employees never contracted pellagra and that pellagra did not develop in those who consumed a mixed, well-balanced diet. Later, Goldberger became convinced that the causal solution lay with chemists and experimental nutritionists. He and his associates found that brewer’s yeast, which prevented and alleviated pellagra, had what he called the “pellagra-preventive-factor.” In 1926, Conrad Elvehjem discovered that Goldberger’s pellagra-preventive-factor was a member of the B-group of vitamins.

In October, 1928, Goldberger gave his last public address on pellagra at the American Dietary Association. In the fall of that year, Goldberger became ill and entered the U.S. Naval Hospital. He was nominated for the Nobel Prize again – now for the fifth time, but he did not win. He died on January 7, 1929 of hypernephroma, diagnosed only at autopsy. Nine years later, a researcher at the University of Wisconsin identified nicotinic acid as the curative factor for pellagra. Goldberger’s activities in the battle against pellagra will be described in more detail later.

George Alexander Wheeler was born on March 10, 1885 in Hog Branch Higgins, Yancey County, North Carolina. He died in Spartanburg, South Carolina on December 24, 1981, which was the same city where he had worked while studying pellagra. When he was 90-years-old he gave an interview about his life experiences battling pellagra. He had joined Goldberger in 1914, as a young medical school graduate with the U.S. Public Health Service, to prove that the dreaded pellagra which was the number one killer in many areas of the South was a dietary deficiency and not a contagious disease. Pellagra was peculiar to sections of Southeastern United States and parts of Italy where food staples – such as corn and maize were lacking necessary food protein. Pellagra was particularly prevalent among low income families in textile communities. Symptoms began with a sore tongue and rash on the hands. The disease often evolved into severe mental disorders leading in some cases to death.

Dr. Wheeler told of vivid memories of those ‘hard times’ when the prevailing medical opinion held that pellagra was a communicable disease. He and Goldberger set up a 45-bed hospital at Spartanburg in 1914 with the intention of proving their theory that pellagra was due to a dietary insufficiency and not a communicable disease. The hospital had a waiting
list of 500 patients at its onset, but by 1922 it closed for lack of patients due to improvements in diet during and immediately following World War I.

By 1914, recalled Dr. Wheeler, the incidence of pellagra had reached the point where ambulant pellagra patients were frequently seen along the streets. A key experiment, said Dr. Wheeler, was one in which fresh blood and other material from pellagra patients was transmitted to healthy volunteers none of whom developed pellagra. Other experiments were carried out at orphanages and custodial institutions in the South. One was at the Epworth Orphanage in Columbia. Here the children were divided into three age groups and fed specific foods. Those under six got milk regularly and remained healthy. Those between thirteen and thirty worked on the orphanage farm and avoided pellagra by eating vegetables. Pellagra cases developed in the six to twelve age bracket. These children subsided on grits, gravy, biscuits, molasses and poor quality fatback known as sow belly. These were staple foods which filled the stomach, were cheap and easily stored. Drs. Goldberger and Wheeler arranged with authorities to include in the diet lean meat and milk. Within a few months, pale, listless children became healthy. Similar results in mental institutions and prisons confirmed their theory.
Edgar Sydenstricker (1881-1934)

“Society has a basic responsibility for assuring, to all its members, healthful conditions of housing and living, a reasonable degree of economic security, proper facilities for curative and preventive medicine and adequate medical care – in fact the control, so far as means are known to science, of all the environmental factors that affect physical and mental well being.” Stated Edgar Sydenstricker from an address read at the Institute of Public Affairs, University of Virginia on July 5, 1935.

Edgar Sydenstricker, who studied pellagra with Goldberger and Wheeler, was born to missionary parents in Shanghai, China on July 15, 1881. Educated at home by his parents until the age 15, he then attended Fredericksburg College in Virginia where he received an A.B. degree in 1900. After two years at Washington and Lee University, he received a Master’s degree with honors in sociology and economics. He then spent three years as principal of the high school at Onancock, VA. His academic year of 1907-1908 was spent at the University of Chicago where he was a post-graduate in political economy.

In the years following he was associated with the U.S. Immigration Commission and made extensive surveys of wages, working conditions and standard of living of industrial workers, especially the foreign born. In
1915, he was appointed as the first Public Health Statistician in the U.S. Public Health Service. Health services in the United States gradually expanded from a concern with sanitation, pure water and control of a few communicable diseases to the development of programs for promoting personal health by education on healthful living, by providing health measures and by increasing the availability of adequate medical care. In 1914, he was transferred to South Carolina to work with Dr. Joseph Goldberger’s team investigating pellagra. His contributions will be detailed below. In short, these studies thoroughly analyzed the economic and social basis of pellagra in the South. Sydenstricker’s contributions to the pellagra studies are notable for their realism, comprehensiveness and methodological vigor. They represent an outstanding example of the effective collaboration of medical and social scientists.

In 1918, Sydenstricker was assigned to study the influenza pandemic with Dr. Wade H. Frost, and the two men wrote at least 25 papers on the history of influenza from 1910 to 1930. In 1920, Sydenstricker’s activity took on new dimensions in the Public Health Service with his appointment as Chief of the Office of Statistical Investigations. New research units, staffed by statisticians and medical officers, were set up within the Office and their progress was under Sydenstricker’s direction. In 1923, he spent a year organizing a statistical and epidemiologic service in the Health Service of the League of Nations. In 1928, he became director of research with the Milbank Fund which appraised health services in the United States.

From 1930 to 1934 he led studies on the effect of the great depression on the health of people which led to the Economic Security Bill that called for the Federal Government to provide more funds for state and local governments in their public health programs. The Economic Security Bill was submitted to Congress in 1934 and became the Social Security Act signed by Franklin D. Roosevelt in 1935. To Sydenstricker’s disappointment, the Act did not provide government payment for medical insurance. On March 19, 1936, at the age of 54, Sydenstricker died suddenly as the result of a cerebral hemorrhage.8
Conrad Arnold Elvehjem, who isolated niacin, was born and raised on a farm in the Norwegian community of McFarland, Wisconsin. The state capital building could be seen from the family farm and Elvehjem would spend his entire career, from undergraduate student to University President, at the University of Wisconsin, Madison. In 1919, he started his college career and chose agricultural chemistry as his major. He received his Ph.D. degree in 1923. In 1928, he presented a paper that showed copper acts by providing material for the synthesis of hemoglobin. Midway through this presentation, the audience gave him a standing ovation.

Elvehjem later developed a program that studied the vitamin B complex. He implicated “Factor W’ as an unidentified growth factor in liver extract, which was required for growth, in addition to the known B vitamins. Omission of this factor in liver extract from the diet resulted in pellagra in chicks. That filtrate extract was designated as the vitamin G fraction in honor of Joseph Goldberger. To confirm their findings in dogs, Elvehjem induced black tongue (dog pellagra) with the Goldberger diet of yellow corn, before supplementing the diet with the vitamin G fraction. Elvehjem and his collaborators isolated niacin (nicotinamide/nicotinic acid)
from vitamin G as the curative factor for black tongue in dogs.\textsuperscript{9,10} A short time after this it was shown that niacin prevented pellagra in humans.

Elvehjem served as Chairman of the Department of Biochemistry at the University of Wisconsin and Dean of the Graduate School. In 1958, he became President of the University. In 1962, at the age of 61, he died of a heart attack while sitting at his desk.\textsuperscript{11}
Lewis Hine (1874-1940)

Lewis Hine was born in Oshkosh, Wisconsin. After finishing high school, he worked at various jobs until enrolling at the University of Chicago in 1900. While at the University of Chicago, Hine met Frank E. Manny, Professor of Education at the State Normal School who had recently been appointed Superintendent of the Ethical Culture School in New York. In 1901, at the invitation of Manny, Hine moved to New York City and accepted a position as an assistant teacher at the ECS. Hine began at this time to use a camera as an educational tool and to photograph school events. Hine also began attending the School of Education in New York.

In 1904, Hine became involved in a project to photograph Ellis Island. Anti-Immigrant sentiment was persuasive and Manny encouraged Hine to portray the newly arrived with the same dignity and respect as those immigrants who landed at Plymouth Rock.

In 1905, Hine had received his degree from New York University. By 1906, Hine was considering a career in Sociological Photography and began to pursue freelance work with the National Child Labor Committee. In 1907, the NCLC gave Hine his first assigned project. Hine was to photograph New York tenements. Later that year, after enrolling at the graduate school
of Columbia University to study sociology, Paul U. Kellogg assigned Hine to a pioneering sociological project, the Pittsburgh Survey. This survey was to be an all encompassing detailed view of a typical industrial city. The survey showed the gap between the largely unskilled immigrant workers and the comfortable middle class of managers, executive and politicians. The goal of the survey was to promote a rational understanding of the social and economic inequalities between the various classes. It was believed that a greater public awareness would result in corrective social action.

In 1908, the NCLC provided Hine with a monthly salary and assigned him to photograph child labor practices. For the next several years, Hine traveled extensively photographing children in mines, factories, canneries, textile mills, street trades and assorted agricultural industries. Hine’s photographs alerted the public to the fact that child labor deprived children of childhood, health, education and a chance of a future. His work on this project was the driving force behind changing the public’s attitude toward child labor and was instrumental in the fight for stricter child labor laws. By 1913, now a successful welfare photographer, Hine continued to travel as well as lecture for the NCLC. Several exhibits, particularly in San Francisco and San Diego, further established his reputation.

In 1917, after his salary at the NCLC was reduced, Hine accepted a position with the American Red Cross. During the next couple of years, Hine photographed refugees and displaced persons in war-torn Europe. After the Armistice, Hine went to the Balkans and in 1919 he published *The Children’s Burden of the Balkans*. During the 1920’s, Hine returned to Ellis Island doing assignments for various agencies and publications. He also undertook various commercial assignments and in 1924 the Art Directors Club of New York awarded him a medal at the Exhibition of Advertising Art.

In spite of the fame and recognition he received, Hine found difficulty in making a living as a photographer. Then, in 1930, Hine was hired to photograph the construction of the Empire State Building. Where much of his previous work had documented the dark side of labor and progress, the Empire State Building photographs celebrated the dignity and productivity of a proud post war American labor force. He was also employed by the Tennessee Valley Authority to record the building of dams.

Over the next ten years, Hine had exhibits in various museums. His book *Men at Work* was published in 1930. In the 1930’s several of his
portfolios including *Through The Loom*, was obtained by the Brooklyn Museum, the Museum of Modern Art, the Metropolitan Museum and were exhibited at the 1933 World’s Fair. From 1936 to 1937, Hine was appointed head photographer for the National Research Project of the Works Progress Administration. Attempts at this time to secure work with the Farm Service Administration proved unsuccessful as Roy Stryker considered Hine unfashionable and difficult to work with.

Despite all the above, Hine had great difficulty earning enough money for his photographs. In January 1940, he lost his home after failing to keep up the mortgage payments. He died in extreme poverty eleven months later on November 3, 1940.\(^\text{12}\)

Photographs and comments of children that worked in the mills, mines and factories in the South can be accessed on the internet: “Hine: Child Labor in the American South.”
The First Description of Pellagra by Casal

Casal authored but one book, his posthumously published encyclopedic treatise Historia Natural y Medica de la Principado de Asturias (1762). This work, the result of thirty years observation, described, in the first part, the topography, climate, winds, waters, flora, fauna minerals, metals, epidemics and diseases of Asturias. The diseases included intestinal parasites, fevers, endemic goiter, scabies and leprosy. The third section, written in Latin, not in Spanish as were the preceding sections, contained a chapter on De affectione quae vulgo in hac regione mal de la rosa nucupatur. Casal referred to pellagra using a Spanish designation (mal de la rosa) that reflected the characteristic sunburn-like erythema of the disease, a term that had been used by the lay populace of Asturias for many years. Casal described an epidemic that he thought was endemic to Asturias. He began by declaring that of all the contemporary disease of Asturias, none compared to this horrible disease. He wrote that the term mal de la rosa described only one of the symptoms of the disease, a frightful red, rough, dry black crust with fissures that penetrated deeply and produced a stench. The disease returned each spring, like the swallow. He described the “cuello rosado” (Casal’s collar is still used) as the appearance of a rough ash-colored seam which, like a collar, extended around the neck over the clavicles and the sternum. The drawing here illustrates the eruption on the feet, dorsum of the hands and the neck. Casal noted that when the sun was hottest and most forceful, the diseased patient became insane and melancholy, abandoned his house and wandered about the hills alone often dying of desperation. Casal also correctly described the gastrointestinal and neurologic manifestations of the disease. Casal speculated that climate and diet were the cause of the disease which was the very first observation of its association with a corn-based diet. He
noted that those affected ate only maize and rarely ate fresh meat. For
treatment, he recommended a change of diet particularly a change to
vegetables and cow’s milk. Casal’s description led to the disease being
known as “Austrian leprosy,” and it is recognized as the first modern
pathologic description of a syndrome.1, 2, 13

**Corn in the New World and Pellagra**

The Spanish brought more than syphilis upon their return from the
New World; they also brought corn (maize) and potato. Although pellagra
was not described until the 1760’s, pellagra has its roots in the beginning of
the 16th century. Before 1492, the agricultural societies of the Old and of
the New World had developed parallel but distinct cereal based dietary
models that relied on wheat and other minor cereals in the Old World and
on maize and other tubers (potato, sweet potato and manioc/cassava) in
the New. In Mediterranean countries, and in particular Italy, which
sustained a relatively large population, frugality had always represented a
necessity in relation to the scarce food production. The foods available in
Italy increased in quantity and variety following improvements in
agriculture, animal husbandry and exchanges within the Mediterranean
region and with Asia during the Middle Ages, the hierarchical stratification
of the society determined a profound divergence between the varied and
excessively abundant diets of the wealthy few and the extreme frugality
tending to seasonal starvation of the lower classes

In the 16th century, the development of trans-Atlantic exchanges
sparked a dietary revolution which in the long run amalgamated the diets
of the Old and New Worlds and thus shaped the modern food system.
However, the wider dietary choices (and the consequent qualitative
variation in foods) that followed the discovery of the Americas was
destined to remain for a very long period an almost exclusive privilege of
the wealthy. Corn and potatoes from the New World could be produced
more easily and at a lower cost than wheat and other Old World cereals.
Thus, in a comparatively short time these two New American foods became
dietary staples of the poor in those parts of Europe that were suitable for
their cultivation, i.e., Northern Europe for potatoes and Southern Europe
(mostly Spain, Portugal and Italy) for maize. Wheat, a preferable grain for
flour and bread, sold at almost double the price of corn and was, therefore,
with other economically valuable food items, almost entirely reserved for the market and the wealthy.

In Italy and Spain, the diffusion of maize as a staple sustained a peasant population at low cost who were harshly exploited for their labor, particularly in the Northern flood plains of Italy that were suitable for intensive agriculture. Thus during the 16\textsuperscript{th} and 17\textsuperscript{th} centuries a quasi-monophagic maize-porridge (\textit{polenta}) based diet without the alkali treatment practiced by the New World American Indian became the central component of the diet of the poor Spanish and Northern Italian peasantry. The Europeans did not know that slaked lime or some other alkaline product like plant ash added to maize by the New World Indians as a preservative to prevent its leafing and spoiling also released the niacin in the corn and thus prevented pellagra. The quite abrupt socio-economically driven switch in dietary habits, combined with the lack of the Indian culinary adaptation, led to the development of the terrible scourge of pellagra in the Italian and Spanish countryside. Goethe, in his voyage to Italy (1786 -1788), descending from the Brenner Pass into the Venetian plain, noted the abrupt change in the facial features and skin color of the population and the pitiful appearance of the children. He concluded that this was due to the continuous use of maize as food.

There was a rising realization that pellagra was a socio-economic disease due to exploitation of peasants by landlords (\textit{malatta del padrone}). However, Italian experts on pellagra almost unanimously agreed that pellagra was due to eating “rotten” corn. From the socio-economic aspect, this theory was also less disruptive than a nutritional deficiency one, because on its basis, pellagra prophylaxis could be limited to improvement in the desiccation and storage of corn, without calling into question the politically and socially sensitive issue of food availability to the lower classes.\textsuperscript{14}

Gosio and Atonini of Italy presented the views of Italian investigators on the etiology of pellagra at the turn of the 20\textsuperscript{th} century.\textsuperscript{15} They reviewed their theory as to the cause of the disease as well as the other theories then extant in Italy. They concluded that the etiology might be simply stated to be “spoiled corn and all its products.” They blamed the improper storage of corn with the subsequent growth of parasitic moulds which acted powerfully on the nervous system and, instead of producing
immunity, hypersensitized the system to react to their repeated stimuli. Just as small quantities of alcohol disastrously affect the alcoholic, so a small amount of mold-infected corn produced the disastrous effect on the nervous system, skin and blood of pellagrins. Gosio and Antonini admitted that there was pellagra without corn because it was simply the case that the *hyphomycosis* of pellagra invaded other foods. They rejected the hypothesis of Tizzoni that *streptobaccilus* caused pellagra or that it was transmitted by the bites of insects that inhabit drinking water such as occurred in malaria. Gosio and Antonini also rejected the dietary theory of the etiology of pellagra. They posited that dietary deficiency may cause a disease that mimics, but is not, true pellagra. They mentioned the theory of Raubitschek that in the parts of the body exposed to the actions of the sun, under the influence of a maize diet, a noxious substance develops which not only induces alterations in the exposed parts, but also does injury to all the systems. They also rejected the view of Ravitcvh-Eissman-Prudy that pellagra was a disease of certain migratory species of blackbirds and was transmitted to man by common flies.\textsuperscript{15}

All who wrote of pellagra in Europe emphasized the extreme poverty of pellagrins, their families and their environment. Casal, who first described pellagra in 1762, although not mentioning poverty *per se* wrote that climate (heat and sun) and diet were the cause of the disease. He thought that it was associated with a corn based diet; that the diseased ate only maize and rarely fresh meat. Roberts was impressed that people in the affected areas of Spain ate mainly Indian corn and a few vegetables and that the decrease in incidence of pellagra in Spain at that time (1913) was due to the general improvement in hygiene, food and cleanliness in the laboring calluses.\textsuperscript{16}

Oliver Ormsby, an American dermatologist, synopsized the corn theories in his textbook published in 1915.\textsuperscript{17} He wrote: “The various theories regarding the production of pellagra are those concerning maize or Indian corn and other agents. The corn theory has been most strongly advanced in Italy. The views relative to this hypothesis may be summarized as follows: (1) Indian corn is deficient in or lacks some nutrient principle necessary for health, and pellagra results from a diet limited to strictly to that cereal. (2) Corn contains some toxic substance which in susceptible individuals produces the disease. (3) Corn undergoes some form of decomposition in the intestine of certain individuals, as the result of the
growth of bacteria, the toxins thus produced exciting the disease. (4) Healthy corn is innocuous, but at some stage in its preparation for consumption, either in the ear, when stored, or after cooked, it undergoes decomposition as the result of growth of certain fungi. In the growth of these organisms, it is supposed that toxins are produced which, when absorbed, induce pellagra. (5) Finally, that some or one of the organisms which are commonly found in moldy or spoiled corn and which may be eaten with it, directly invades the body and produces the disease.”

F.M. Sandwith, an Englishman, had this to say about the cause of pellagra: “There are four prominent theories about the etiology of pellagra under consideration today. 1. That it is a disease in some way associated with maize. 2. The pellagra is a protozoal disease, probably transmitted and propagated by a Simulium or some other insect. 3. That pellagra is contracted in definite zones where the usual drinking water comes from springs arising in argillaceous soil, or from streams and stagnant pools in a clayish district. 4. That pellagra is due to a streptobacillus found in Professor Tizzoni’s laboratory in Bologna during the last three years in blood, cerebro-spinal fluid and feces during life, and in organs after death.”

Pellagra in Spain

Stewart Ralph Roberts visited Spain in 1911. He studied pellagra there and had this to say:

“Pellagra originated in the northern part of Spain on either side of the Cantabrian range of mountains, which forms that part of Spain known originally as the Asturias, but which is now on the northern side of the mountains, the province of Oviedo and on the southern side the province of Leon...Townsend, an Englishman, in his Travels Through Spain (1787), in writing of a visit he made to the hospital at Oviedo, the capital of the Asturias, refers to mal de la rosa, the first reference to the disease I have been able to find in the English language. Of this hospital he says: ‘The most remarkable cases were tertians, dropsies, and a disease peculiar to this province called mal del la rosa. This disease is considered a species of leprosy, and descends the sternum nearly to the process xiphoides. Those who suffer with this disease have a peculiar propensity to drown themselves. When the disease is neglected, it terminates in scrofula, marasma, melancholy, and madness. The people among whom it originates
eat little flesh in their food; they drink little wine. Their usual diet is Indian corn with beans, peas, chestnuts, apples, pears, melons, cucumbers; and even their bread made of Indian corn has neither barm nor leaven, but is unfermented and in a state of dough. Their drink is water.

“From the province of Oviedo pellagra spread westward into northern Portugal and south into the provinces of Leon, lower Aragon, and Burgos. The second focus of pellagra in Spain seems to have been in the province of Guadalajara, just west of Madrid and in the midst of the Sierra de Guadalajara mountains. The third focus was in southern Spain in the province of Granada in the midst of the many ranges of mountains in southern Spain.

“The Academy of Medicine in Barcelona in 1879 made an investigation of the prevalence of pellagra in Spain and, with certain exceptions, the following facts may be accepted: The Asturias were the chief center of the disease at that time, and to a lesser degree lower Aragon and Burgos. In fifty villages of the province of Guadalajara 2 percent of the population were affected. The other provinces chiefly affected at that time were Cuenca, Navarra, Zaragoza, Zamora and Galicia. A few cases were found in all the other provinces in Spain. Since that time (1879) the number of cases has decreased and the severity of the disease has greatly lessened. From a report of the Fourteenth International Medical Congress, held in Madrid in 1903, it appears that only twenty cases were observed in the Asturian districts where the disease became first known. There has been a marked decrease in the number of cases since 1900. Nearly all of the twenty cases above mentioned terminated by death of the infected person, largely on account of lesions of the spinal cord. It is stated that the rapid decrease of the pellagra has been due to the general improvement in hygiene, food and cleanliness of the laboring classes.”

Pellagra in Italy

Stewart Ralph Roberts wrote this about pellagra in Italy: 16 pages 48-53

“Pellagra was certainly present in Italy in 1720 and probably existed in northern Italy as early as 1700. Despite the fact that it first appeared in Spain, more cases have appeared in Italy than anywhere else in the world, and that country may rightfully be called the home of the disease. Pellagra has existed in forty-four out of the sixty-nine provinces in Italy. The disease
first appeared in the north and then spread gradually southward, but always tended more to the east than to the west. It has avoided the insular possessions of Italy and, strange to say, does not seem to have appeared in Corsica, Sardinia and Sicily.

“According to four different censuses the deaths from pellagra decreased from 3,987 in 1898 to 2,359 in 1905 and the incidence of the disease decreased from its high of 104,067 in 1881 to 55,029 in 1905. I found a good illustration of this decrease in the Ospital Maggiore in Milan. In former years several legacies were left to this hospital, the income of which was to be used in the treatment of pellagrins. The number of cases in the district of Milan and even in the adjacent country around the city had decreased to such an extent that there were practically no cases to report. This is in harmony with the history and almost complete extinction in Spain [in 1911].

“Italian authorities who linked pellagra to eating of bad corn are called Zeists. They noticed that two similar villages had markedly different incidences of pellagra. The people of Morono who lived on fish had no cases of pellagra, while the inhabitants of the village of Sesto, where there were 700 cases of pellagra out of 3,700 people, ate a great deal of imported corn. The authorities did link diet to pellagra, but only because the poor were unable to afford good corn. The Italian passed “corn” laws. People were encouraged to turn in “bad” corn and receive “good” corn and were then fed a healthy meal. This was not effective because the “bad” corn was resold and poor people, pellagrins or no, came for the free meal.

“At the present time [1911] there are four important pellagrossari in Italy; at Inzago, Citta di Castello, Mogliano, Veneto and at Rovereta in the Austrian Tyrol. At all of these the inmates are decreasing, and, as Dr. Bresadola remarked to me at Rovereta, ‘soon the building will have to be used for other purposes, because there will be no more pellagrins.’”

The Mariani-Constantis noted a progressive decline of the disease in endemic areas of Italy from 344 cases/100,000 in 1897 to 122 cases/100,000 in 1909. The Constanti’s attributed the decline between the end of the 19th century and the first quarter of the 20th century to the general improvement in socio-economic conditions and health of the peasantry. The continued economic improvement combined with specific
and effective prevention led to the complete disappearance of pellagra in Italy between 1950 and 1955.\textsuperscript{14}

\textbf{An Epidemic Waiting to Happen – The Corn Controversy}

The specific reason for the explosive nature of the outbreak of pellagra in the southern United States will never be known, although several contributing factors were probably significant. Pellagra was much more common in the southern states where income was low, most of the available land was used for nonfood crops such as cotton and tobacco, and corn products were a dietary staple.\textsuperscript{19} Cotton was ruinously cheap and wages correspondingly low, while food prices were very high. Very few animals for food were raised, and Western meat was beyond the means of the tenant.

Corn was first implicated the United States as a cause of pellagra as soon as the disease was described here. Before 1900, the bulk of the meal used in smaller towns and practically all that consumed in rural areas was locally ground in grist mills which more often than not were water driven. “Water ground” meal was coarsely bolted or not at all and retained much of the germ and hull of the grain. About the turn of the twentieth century, finely bolted meal produced by large milling companies made its appearance. This so-called Western meal was thoroughly degerminated to prevent the development of rancidity during shipment. The meal looked better, kept better, and made more palatable bread. Also, it was simpler for the countryman to go to the store commissary and buy a sack of meal than to haul corn to the grist mill and return in a day or two for the ground product. In the towns, the keeping qualities of Western meal appealed to the grocers, so they stocked it exclusively. Thus, in a few years the staple cereal food of millions was changed, from what was essentially a whole grain to a rather highly refined carbohydrate that was particularly low in niacin.\textsuperscript{2}

Corn was the principle crop of the country and big money was involved. Because northern farmers harvested the corn by machinery, the ears did not get enough air and sunshine to dry the corn properly and the corn sometimes fermented. In the South, the corn was still harvested by hand. The fodder was pulled out and the ear allowed to stand in the field
two months or so and thoroughly dried out. Perhaps in it was the moldy Northern corn that caused pellagra. In the South, there was an outcry against Northern corn. Rumors arose that corn caused pellagra or that cottonseed oil and/or alcoholism were the culprits. Patients were shunned because pellagra was thought to be wildly contagious. Bizarre and often harmful remedies were tried. This panic coined a new word, pellagrophobia. Search for a pellagra cure led to a profusion of bizarre remedies.\textsuperscript{5} This confusion persisted for years.

Voegtlin \textit{et al} in 1961\textsuperscript{20} had noted that the modern milling of white bread prized by housewives, was instead a distinctly inferior product that was made entirely of but one part of the grain, the starchy endothelium. The corn did not have the same nutritive values it had when included the germ and grain as well. Highly milled products contained less protein, ash and fat than old-fashioned products. More importantly, highly milled products contained fewer vitamins, or “essential accessory food substances” which were located on the outer layers of the grain and perhaps the germ. Cooking with artificial leavening began because the finished highly milled bread was lighter. Baking soda became popular but it had strong alkali detrimental to vitamins.

Ironically, the proponents of eating corn as the cause of pellagra had a basis in fact. The traditional food preparation of corn by the Indians of Latin America required treatment of the grain with lime, an alkali (nixtamalization – \textit{nixtamil}, an Indian word). The earliest use of nixtamalization was in what is present-day southern Mexico and Guatemala around 1500-1200 BC. This removes the husk producing a softer product more easily ground. Soaking the corn in lye also kills the seed’s germ, which keeps it from sprouting while in storage. In addition to preserving the grain as foodstuff, this process also affords several significant nutritional advantages over untreated maize products. It converts some of the niacin (and possibly other B vitamins) into a form more absorbable by the body, improves the availability of amino acids, and (at least in the lime-treated variant) supplements the calcium content, balancing maize’s comparative excess of phosphorous.\textsuperscript{21}

When corn cultivation was adopted worldwide, this preparation was not accepted, because the benefit was not understood. Pellagra became common in the New World only when corn became a stable that was eaten
without the traditional treatment. Goldberger had stumbled upon the treatment of pellagra early on when studying yellow fever in Mexico, but did not realize it. He noted that part of the yellow fever problem in Mexico arose from the national custom of using lye water for softening the outer shell of the cover (unleavened bread) in the preparation of the tortilla. He found that lye water receptacles were an excellent culture medium for the *stegomyiae* larva and campaigned against the use of lye. If he had encouraged the use of lye in the preparation of corn and this had been accepted, pellagra might not have existed.

The different methods of harvesting and drying the corn, how it was milled, whether or not was bolted or degerminated or moldy or not or whether it was white or how it was cooked had little to do with the connection between corn and pellagra. Corn that was treated with lye as did the Indians of Latin-America had everything to do with the relationship between corn and pellagra.

**Clinical Description of Pellagra**

In 1915 Oliver Ormsby published the first edition of his textbook of dermatology which, in many editions, was the standard textbook of dermatology for thirty-five years. He described in detail the dermatologic manifestations of pellagra. He wrote:

“Pellagra became endemic in the U.S. in about 1907. The southern states have furnished the majority of cases. It was only since 1907 that pellagra has assumed important proportions in this country. The earliest symptoms may be connected with the skin or gastro-intestinal tract. Occasionally, the patient suffers what is presumed to be a sunburn and is indisposed for a short time. The symptoms then clear up, to return the next year or at some future date.

“In other cases, a moderately sore mouth, with some gastro-intestinal disturbance, particularly diarrhea, occurs, but is considered to be of no consequence, and in the course of a few weeks, the symptoms subside, only to recur at some future time. During the winter months the patients are often entirely well. With each recurrence, the symptoms are apt to be exaggerated, although at times they have been noted to be more mild.
“A certain proportion of cases begin with gastro-intestinal symptoms, consisting of chronic and often severe diarrhea with more or less stomatitis. These symptoms in certain cases have lasted for one or two months before the appearance of the dermatitis. In such cases the latter is usually exaggerated and of the bullous type. In other cases, the disease runs a more chronic course, exhibiting mild symptoms. In still other cases, the disease may be acute and severe (Pellagra typhosis), the patient having a high temperature, severe diarrhea, and stomatitis, delirium and other evidences of intense intoxication. Seasonal recurrence has been emphasized by all observers. The disease has been noted to occur most often in the spring and autumn. In a certain proportion of cases, after an attack has occurred in the spring, a recurrence takes place in the autumn.

“In observing the development of these lesions, it is noted that at first there often occurs macular lesions, light or dark-red in tint, which soon fuse, forming a patch of dermatitis almost identical in appearance with that caused by the sun.
“As the evolution of the disease advances, the color of the lesions deepens and they assume a reddish-brown or chocolate hue. In from seven to ten days, or a little longer, desquamation begins, at which time a roughened, scaling surface is present. Early in the process there is moderately marked swelling. In the more active cases, on the erythematous base, there develop bullous lesions, which often attain a large size, and which, after a few days, gradually dry, leaving a thickened crusted epidermis.
“Ecchymoses not infrequently complicate the process and secondary pyogenic infection may follow. In the vesicular and bullous severe cases, ulceration may ensue; in many cases the edema is sufficient to produce fissures. Whether erythematous or bullous, the lesions are always well defined. After the eruption has disappeared, the skin in some cases is pigmented; in others the pigment is lessened. In certain cases, where the process is less acute, the appearance is permanently thickened, hard, roughened, scaly and pigmented. The terminal stage is exhibited as a thin cicatriform, parchment-like integument, presenting striae parallel with the long axis of the hand.
“The lesions are found on the exposed parts of the body chiefly, and their arrangement is characteristic. In the major portion, the dorsa of the hands, the wrists, and some parts of the face, neck or scalp are involved, the feet and ankle more rarely.
“The arms and chest, and to a lesser extent the ears and other parts of the body, including the palms and the genital region, are also involved. The symmetry of the lesions is striking. On the hands, often a solid area extends over the entire dorsal surface, involving the fingers, knuckles, and also the wrist on the extensor surface for a distance of about two inches. In this area, the lesions frequently sweep around and involve about two-thirds of the flexor surface and then come to an abrupt ending [pellagra gloves].

*Pellagra “gloves”*

*Pellagra – Casal’s collar, butterfly rash cheeks*
“Characteristic is the partial gauntlet of the neck and upper chest (Casal’s collar). That the rays of the sun are a factor in determining the localization of the lesions is accepted by all observers...Subjective symptoms, as a rule, are not marked, and are exhibited as burning rather than itching, the surface practically never showing evidence of scratching.

“In the gastro-intestinal system diarrhea is a constant concomitant in severe cases; in mild cases this may be absent and constipation [may] be present. The appearance of the tongue is important. This becomes swollen and denuded, presenting a dry appearance, with, in severe cases, more or less superficial ulceration along its edges and upon its under surface with yellowish sloughing, which bleeds easily. A resemblance to the aphthous stomatitis seen in other debilitated states is noted. The ulcers are very superficial and heal without scar formation. In mild cases, the tongue is reddened and presents smooth areas especially along the tip and along the margins, a condition to which the term bald tongue has been applied. The nervous system chiefly presents the symptoms induced by acute intoxication...In the terminal stages of pellagra the symptom complex [is] that belonging to central neuritis.

“In the recurrences that take place from year to year, the general symptoms become more marked. The gastro-intestinal are indicated by dyspepsia, pains in the abdomen and dysentery. Pains are described as occurring in various parts of the body, particularly the head, epigastrium, and feet, with burning sensations in these same areas. Tenderness on pressure over the spinal cord; muscular weakness and loss of muscle power, particularly in the legs; tremors of the head and arms, mental worry and depression, anxiety and discontent, loss of memory, vertigo, and vague feelings of pressure, weight or pulsation about the head, all may occur. In some cases the subjects are excitable and irritable, in others stupid and morose.

“In the terminal stage, extreme weakness and emaciation, from the preceding severe gastro-intestinal disturbances, profound prostration, delirium, with involuntary evacuation of the bladder and bowels, close the scene...The duration of the disease extends over periods varying from one to twenty years. Five years is probably the average.”
Ormsby concluded by noting that, “the disease is regarded by most observers as not contagious.” The pathologic findings of the skin and in post-mortem examination were not specific. Ormsby’s only recommended therapy was, “improvement of nutrition as being of the highest importance, while internal medication has been of little value.”

Stewart Ralph Roberts, M.D., professor of medicine at Atlanta Medical College, described in extensive detail the clinical manifestations of pellagra in 1913 gleaned from his studies in Europe and the United States:

“Acute pellagra - Malignant pellagra characterizes this attack. It lasts from one week to three months and progresses rapidly to conclusion. It is fatal as a rule. It is also called typhoid, florid, tetanic, or fulminating pellagra.

“Subacute pellagra – Lasts over two years and ends in death or recoveries. It has two divisions: (a) Mild subchronic pellagra or
convalescent pellagra – There are one or two mild attacks, ending in recovery without subsequent recurrence. Pellagrous boys, after one or two mild attacks, may develop into healthy men. (b) Severe subchronic pellagra or cachectic pellagra - From the first attack there is rapid emaciation. The symptoms are pronounced and cachexia comes quickly. There are no intermissions as in the chronic form, and death ensues in two years or less.

“Chronic pellagra – This is the usual type in point of time and it may last from three to thirty years, recurring each spring or at longer intervals. It is mild and slowly progressive. Each stage in chronic pellagra consists of recurrent attacks of activity and times of intermission, or inactivity of the pellagrous advance. It may end in apparent recovery, in insanity, or in death.

“The Initial Degree – Stage of Dyspepsia. The presenting symptom in the initial stage is dyspepsia. It consists of one or two attacks a year; usually the spring attack is persistent and the autumn attack is not constant. In this stage the attack may be mild and lasts from one to four weeks. It may be so mild that it passes unnoticed, and this may occur several years in succession before it is severe enough to arouse the suspicion of the patient. The dermatitis in the first few years may be considered a sunburn. The appetite is good, except in the height of the attack in marked cases. In the majority of pellagrins the bowels tend to relaxation, more during the attack and less in the intermission, but constipation occurs. Dyspepsia, bulimia and gas in the intestine are usually present at various times. Toward the end of this stage, symptoms of neurasthenia begin to creep in, less work is done, headache comes, the spirit lack buoyancy, and the walk is not so rapid and elastic. Mental activity lessens.

“Confirmed Degree – Stage of Neurasthenia. The duration is from one to ten years. The attacks at this stage differ from those of the dyspeptic stage, in degree rather than quality, and in the aggravation of the symptoms of the first stage rather than the introduction of new symptoms. The attacks are certainly more severe, last longer, recovery from them is slower, and their permanent results strike deeper into the mental and physical strength. The cutaneous involvement throughout the course of chronic pellagra pursues a beaten track, while the new symptoms refer to the greater involvement of the nervous system and the appearance of symptoms which are signs of this new and more serious turn of the disease.
The great difference in the first two stages is not in the attacks in the spring or fall, but in the marked difference in the pellagrin between the attacks. In the second stage, he is a confirmed neurasthenic all the time. In the neurasthenic stage, loss of flesh is permanent, the body is bent and the walk is aged, at times staggering. Weakness of the muscles is evident, fatigue comes after little exercise. Later in this stage the pellagrin develops tremors, cramps, contractures, cataleptic and epileptic states, tetanic movements, tendencies to fall in all directions, uncertainly in all things.

“Degree of Desperation – Stage of Cachexia. The duration is from one to five years, usually short. Dermatitis, indigestion, neurasthenia, and feebleness combined with prostration cachexia and insanity added, occur in the degree of desperation. Invalidism is the rule here. Paralysis, paraplegia, and hemiplegia occur. Diarrhea may become blood streaked, mucus may be found in the stool, and a serious diarrhea unyielding to any treatment, ends in death

“The Skin in Pellagra - In the first few years the skin disease may be considered a sunburn. After the attack in the spring and during the fall and winter the skin is frequently apparently normal. The dermatitis involves the flexor surface of the forearms. Usually it is eczematoid in character, partaking in appearance and feeling of a dry, scaly eczema. When vesicles occur, it is known as the “wet form.” It may be of the ordinary erythematous type, and a few small vesicles may develop on the center of the back of each hand. Blisters may develop. In the more severe cases the vesicles become bullae covering the back of the hand. Above the wrist and occurring with the dermatitis is the typical dermatagra. It involves the flexor surface of the forearm and the elbow joint over the olecranon process. Usually it is eczematoid in character, partaking in appearance and feel of a dry, scaly eczema. A discrete dermatitis may occur around the lips or the pellagrous mask may cover the face with exfoliation. Sparing of the skin beneath rings, seemed to show some protection from the dermatitis when the parts were not exposed to the sun. Later, even in intermissions, the back of the hand is pigmented. The elbows are rough and the skin over them becomes thick.

“A symmetrical dermatitis may appear over the malar bones, below and behind the ear, and crescentic ecchymosis or dermatitis, always symmetrical, develops on the lower and upper lids. The dermatitis may
surround the neck with a sternal prolongation which forms the Spanish cravat of Casal (Casal’s collar). The perineum, vulva, and anal regions in the female are attacked by the dermatitis. In the more serious cases the dermatitis may extend from the inner surface of the thighs upward and backwards to the anus and the gluteal region. An acute vaginitis may be present. The dermatitis may occur in the folds of the labia majora and minora similar in character to the stomatitis.

The clinical descriptions of pellagra by Ormsby and Roberts were reviewed at length to impress upon the reader the effects of pellagra even in patients that it does not kill and because the diagnosis of pellagra is made by the clinical signs and symptoms descriptions of which are not found in contemporary texts.

The First Cases of Pellagra in the United States:
The Meetings of the National Associations for the Study of Pellagra:
The Appearances of Drs. Grimm and Goldwater

Pellagra was first discovered and reported in America in 1864 by John T. Gray of Utica, New York. During the American Civil War, the disease was diagnosed, in retrospect, among Union prisoners at Andersonville, Georgia, but any confirmation of it is lacking. However, it seems unlikely that pellagra was endemic before 1900. From all the evidence, it is probable that the disease existed in the Carolinas and Georgia in the early eighties, though the cases were not diagnosed as pellagra and the disease itself was unknown.

George H. Searcy M.D. recognized pellagra among the inmates of the Mt. Vernon annex to the Bryce Hospital for the Alabama State Insane Asylum for Negroes in Tuscaloosa. He described 88 cases, with a mortality rate of 64 percent in the Alabama State Medical journal in 1907.22 Most of the patients had been in good physical health before hospitalization. Two-thirds had been in the hospital for more than a year. None of the nurses attending the patients were affected despite handling the patients and sleeping in the halls near the wards. The patients consumed a monotonous corn-based diet, while the nurses ate a nutritious and varied diet. Searcy was aware of the literature implicating consumption of damaged corn as the cause of pellagra among Europeans. Hence, Searcy blamed the
consumption of moldy and spoiled corn as the cause of the devastating epidemic.\textsuperscript{22, 23}

The disease then began to be diagnosed in other mental hospitals. In 1908, Dr. James Babcock, the superintendent of the State Hospital for the Insane in Columbia, South Carolina, realized that patients in that hospital were dying of a new disease which he had not seen before. Because of the earlier reports of the outbreak of pellagra in mental hospitals, he diagnosed the new disease as pellagra and reported it in the \textit{American Journal of Insanity} in 1912.\textsuperscript{24} The new disease rapidly increased in frequency, and it began to be recognized in inmates of prisons, orphanages and in the general population. Babcock mentioned proved and unproved sporadic cases of pellagra as far back as in the Southern prisons in the Civil War. He discussed the problem of denial by physicians in charge of asylums and discussed probable cases in insane asylums as far back as 1834.\textsuperscript{24}

Influenced by Babcock and Senator Benjamin Tillman of South Carolina, who had traveled together to Italy and visited pellagra hospitals there, the governor of South Carolina, Martin Ansell called interested people together for a First National Conference on Pellagra held in Columbia S.C. on November 3 and 4, 1909.

In the welcoming address, Governor Ansell credited Dr. James Babcock as the discoverer of pellagra in the United States. Dr. Babcock denied that he had been the first to observe pellagra in the U.S., Babcock mentioned that the disease was discussed at a meeting of asylum superintendents in Washington as far back as 1864. Babcock named various physicians, all from the South, who had reported cases of pellagra in the past.

At the Conference, F. Sandwith, of London, in a written communication claimed that maize, damaged by \textit{penicillium glaucum} caused pellagra. F.W. Kerr of the U.S. Public Health and Marin Hospital Service denied that there existed any evidence that pellagra was contagious. E.J. Wilson pointed out that corn was the principle crop of the United States, worth as much as cotton, hay and grain combined. He speculated that corn spoils when it is shipped to the South and recommended that people of the South raise their own food supplies. Other lectures focused on pellagra in different locales, the hematology and
pathology of the disease, that pellagra is caused by *aspergillus fumigates*, case reports and its effect on the brain and genitourinary systems.

The Second Triennial Meeting of the National Association for the Study of Pellagra took place in Columbia South Carolina on October 3rd and 4th, 1914. Many of those who read papers discussed theories of causation such as infections, sanitary conditions and cotton seed oil. Lecturers reported their results of urinary and fecal examinations as well as drug treatments in pellagra. The more germane presentations are quoted in detail.

Rupert Blue, D.SC. Surgeon General U.S. Public Health Service, Washington. D.C. reported: “There are at the present time four well defined theories as to the causal agents [of pellagra], namely infection, intoxication, auto-intoxication, and food ‘deficiency.’ I shall consider only the first and fourth of these theories. Some of the exponents of infection are Ceni, di Pietro and Tizzone [of Italy], each of whom has found different micro-organisms either in maize or in the bodies of patients and which they credit with the power of producing the disease. Their findings still lack confirmation. Sandwith, of London, advanced the protozoal theory...He believes that the disease is transmitted from man to man by the bite of a fly, the *Simulium reptans*...Professor Allesandrini, of Italy, is credited with the nematode hypothesis. The infection, according to that investigator, was derived from a worm which is found in running water. A second promising line of investigation as regard the causation of the disease is to be found in the deficiency theory advanced by Casimir Funk. He states that it is beyond doubt that pellagra has some close connections with maize diet. Pellagra is thus placed in the same category with scurvy and beriberi.”

Grimm, R.H. Assistant Surgeon, United Sates Public Health Service spoke on Pellagra at the Second Annual Meeting: “The factory people were mostly of the cotton mill class, a class quite common in South Carolina and Georgia. These people live in little villages located around the cotton mills in which they work. Very few of them own their own homes or seem to care to, but live in cottages owned by the milling companies. They are nomadic in character and move from village to village as the notion strikes them. As a class they appeared to be very poor, overworked and underfed, and living on what they earned from day to day and week to week. Although in many instances the total earnings of the families appeared
quite sufficient for comfortable living, they did not seem to understand the
art of applying this income toward the betterment of their living conditions.
Many of the women and girls of this class work in the cotton mills and
contribute to the support of their families. In the counties of South Carolina
and Georgia that I visited, pellagra was found to be much more prevalent
among people of this class than among those of any other. In some of the
villages visited the pellagra situation was alarming.

“The pellagrins of the mining class were for the most part members
of families of coal miners. They were living in small houses and shacks
owned by the mining companies and located on the hillsides near the coal
mines. They were found to be living a hand-to-mouth existence, depending
for their support on the daily wages of the workers in the mines. The
majority of them were living amid squalid surroundings, and many of them
lacked even the rudiment of an ordinary school education.

“The forty-eight pellagrins of the agricultural class were mostly of
families of ‘renters’ or ‘croppers.’ Some were land owners, a few of whom
appeared to be prosperous. Many, however, were typical ‘Georgia
crackers.’ The majority of pellagrins in the remaining groups, while living in
towns and in an environment somewhat better than found in the mill
villages and mining camps, still were living under conditions far below the
average. A few, however, were enjoying comforts of an environment far
above the average. The great majority of pellagrins were living in poverty
with bad sanitation.

“Food – It was learned that the great majority of the pellagrins in this
series had been subsiding almost entirely on food bought at the stores. The
families among the cotton mill and coal mining classes were practically
entirely dependent for their supplies on the small stores in the villages and
camps, and despite the rural locations of the homes in the pellagrins of the
agricultural class, they too were found to depend to a considerable extent
for their food on the country grocery stores. It was the exception to find a
pellagrin who could state that even the major part of the food used in the
family had been home grown. Necessarily, the lines and quality of the
groceries are regulated largely by the finances, the tastes and demands of
the patrons, and judging on this basis it can be said that the quality of
goods of these stores was certainly not of the best, nor were the goods of
the freshest...Much of the food had undergone some process for its
preservation, such as desiccation, canning etc. It seemed to be the consensus of opinion of doctors practicing among these peoples that most of them were not receiving the proper quality and quantity of food, and that even when obtained in sufficient quantity it received hasty and incomplete culinary preparation. No constant difference, however, was found to have existed between the diets of the pellagrous and non-pellagrous members of the families.

“Indian corn – Each one of the pellagrins considered here gave a history of the more or less regular use of corn products as articles of diet. Some acknowledged only a limited use of them, while others stated that they had ‘lived on corn bread and hominy.’ Hominy and meal seemed to be the forms of corn in most common use, and in all except three instances some of the meal used by the pellagrins previous to the onset of the disease had been so obtained. The stores were found to handle both locally grown corn and corn and meal imported from other states. The local mills of the districts visited were also found to grind both kinds, so it was practically impossible to determine the relative amounts of each which were being used by the peoples. In considering the subject of corn in its possible relation to pellagra in the districts visited, it must be remembered that these districts belong to the great corn-eating section of the country, where for many years corn, in one form or another, has been the main article of diet for all classes and where for many years the demand for corn has not been equaled by the local supply.

“Heredity – None of my observations in this work has led me to believe that pellagra is hereditary.” Grimm found pellagra in workers and families in the mines and on farms as well as those working in the mills. Although we will concentrate here on mill workers and their families, pellagra occurred in all of the very poor in the South.

At the Third Triennial Convention of the National Association for the Study of Pellagra held at Columbia South Carolina in 1915, Goldberger spoke although he had only been assigned to head the Public Health Service pellagra study in 1914:

“The writer desires to invite attention to certain observations recorded in the literature of pellagra the significance of which appears entirely to have escaped attention. Siler and Nichols in their paper on the Aspects of the pellagra problems in Illinois (Transactions 1909 p53-75)
stated that certain facts ‘would seem to indicate that the exciting cause of the disease is present within the institution’ (Peoria State Hospital), and add that ‘at the present time no nurses, attendants or employees have shown the disease.’ Manning, medical superintendent of the asylum at Bridgetown, Barbados, on the same occasion, in arguing against the identity of a disease that he called *psilosis pigmentosa* with pellagra, but which undoubtedly is this disease, states that he had never seen it develop in an attendant. (Transactions 1909 pp110-114)

“At the same conference Mobly, from the Georgia State Sanitarium, in the course of his discussion of the relation of pellagra to insanity, presented data showing that at the Georgia State Sanitarium a considerable portion of the cases of pellagra develop in inmates who had been resident therein for considerable periods, mentioning one case in an inmate after a 10 year residence. In this connection he remarks, what must have struck him, as it no doubt must have appealed to Siler and Nichols at the Illinois institution, as a curious fact that ‘so far as can be ascertained there has never been a case of pellagra to develop among the nurses, white or colored, while employed as such in the Georgia State Sanitarium.’ (Transactions 1909 pp137-147)

“Sanborn in his *Progress Report* states that in Italy ‘no precautions are ever taken to avoid propagation of the malady in any of the *pellagrosari, locande sanitarie*, hospitals, insane asylums and other institutions in which very numerous pellagrins are collected every year. Long experience has taught that there is no danger whatever of transmission from the sick to the healthy in any collective dwelling within urban precincts.

“Sanborn’s statement is confirmed by Lavinder, who in a personal communication states that on careful inquiry while visiting a large *pellagrosario* near Venice, one in which some 300 to 600 pellagrins are constantly present and cared for by a large number of Sisters of Charity and other employees, he was assured that no employee had ever developed this disease while at the institution.

“The results of personal inquiry at some of our State institutions in which pellagra occurs confirm the reported observations cited above. Thus, at the South Carolina State Hospital for the Insane, where Babcock states that pellagra develops in patients who have been there for years, no case
as far as the writer was able to ascertain, [has pellagra] occurred in the nurses or attendants. It may be of interest to recall in this connection that in his annual report for 1913 Babcock states that a total of about 900 pellagrins had been admitted to his institution during the preceding six years.

“At the State hospital for the insane at Jackson Miss., there have been recorded 98 deaths from pellagra for the period between October 1, 1909 and July 1, 1913. At this institution, cases of institutional origin have occurred in inmates. Dr. J.C. Herrington, assistant physician and pathologist, told me at the time of my visit of a case in an inmate after 15 and in another after 20 years’ residence at the institution. No case, so far as I was able to learn, has developed in a nurse or attendant, although since January 1, 1909, there have been employed a total of 126 who have served for periods of 1 to 5 years.

“In considering the significance of the foregoing observations it is to be recalled that at all of these institutions the ward personnel, nurses, and attendants spend a considerable portion of the 24 hours, on day or night duty, in close association with the inmates; indeed at many of these institutions, for lack of a separate building or special residence for the nurses, these live right in the wards with and of necessity under exactly the same conditions as the inmates.

“It is striking therefore that although many inmates develop pellagra after varying periods of institutional residence, some even after 10 or 20 years of institutional life, and therefore it seems permissible to infer, as the result of the operation within the institution of the exciting cause or causes, yet nurses and attendants living under identical conditions appear uniformly to be immune. If pellagra be a communicable disease why should there be this exemption of the nurses and attendants?

“To the writer this peculiar exemption or immunity is inexplicable on the assumption that pellagra is communicable. Neither ‘contact’ in any sense nor insect transmission is capable of explaining such a phenomenon, except on the assumption of an incubation or latent period extending over 10 to 20 years. In support of such assumption there exists, as far as the writer is aware, no satisfactory evidence.
“The explanation of the peculiar exemption under discussion will be found, in the opinion of the writer, in a difference in the diet of the two groups of residents. At some of the institutions there is a manifest difference in this regard; in others, none is apparent.

“The latter would seem to be a fatal objection to this explanation, but a moment of consideration will show that such is not necessarily the case. The writer from personal observation has found that although the nurses and attendants may apparently receive the same food, there is nevertheless a difference in that the nurses have the privilege - which they exercise – of selecting the best and the greatest variety for themselves. Moreover, it must not be overlooked that nurses and attendants have opportunities for supplementing the institutional dietary that the inmates as a rule have not.

“In this connection brief reference must be made to two other epidemiological features of pellagra. It is universally agreed (1) that this disease is essentially rural, and (2) associated with poverty. Now there is plenty of poverty and all its concomitants in all cities, and the question naturally arises why its greater predilection for rural poverty? What important difference is there between the elements of poverty in our slums and those of poverty in rural dwellers? This difference relates to the dietary. Studies of urban and rural diets (Wait-Office of Experiment Stations, Bull.221, 1909) have shown that that the very poor of cities have a more varied diet, than the poor in rural sections. ‘Except in extreme cases, the city poor...appear to be better nourished than the mountaineers’ in Tennessee.’

“With regard to the question of just what in the dietary is responsible, the writer has no opinion to express. From a study of certain institutional dietaries; however, he has gained the impression that vegetables and cereals form a much greater proportion in them than they do in the dietaries of well-to-do people; that is, people who are not, as a class, subject to pellagra.

“The writer is satisfied that the consumption of corn or corn products is not essential to the production of pellagra, but this does not mean that corn, the best of corn, or corn products, however nutritious and however high in caloric value they may be, are objectionable when forming of
themselves or in combination with other cereals and with vegetables, a large part of the diet of the individual.

“In view of the great uncertainty that exists as to the true cause of pellagra, it may not be amiss to suggest that pending the final solution of this problem it may be well to attempt to prevent the disease by improving the dietary of these among whom its seems most prevalent. In this direction I would urge the reduction in cereals, vegetables, and canned food that enter in so large an extent into the dietary of many of the people in the South and an increase in the fresh animal food components such as fresh meat, eggs and milk.

“It may be of interest to add that intensive studies along the lines so strongly suggested by the observations above considered are being prosecuted by several groups of workers of the United States Public health Service.”

This article was reprinted from the Public Health Reports of June 25, 1914 Vol. 26 in the Public Health Reports of July-August 1975, Vol 90, No 4; 373-5. With the following note, “In commemoration of the Bicentennial of the United States PUBLIC HEALTH REPORTS is reprinting in each issue an article of historical significance to public health.” Goldberger had decided that an inadequate diet was the precipitating cause of pellagra before he had begun his investigations.

Dr. James H. Hayne, the chief public health official of South Carolina disagreed vehemently with Goldberger’s diet theory. Hayne claimed that, “even if Goldberger’s dietary theory were correct, it left state public health officers with the dilemma of having to find a way to change the mode of living of the whole people of a state. That, Hayne said, would be almost impossible. 6 page 118

Theories of the Cause of Pellagra by Americans

Two teams of the United States were the chief investigators of the cause of pellagra; those of the Thompson-McFadden Commission and those from the United States Public Health Service. The former concluded that pellagra was due to bacteria with an insect vector and was an infectious disease. The latter concentrated their efforts on the socio-economic conditions of the American South in general and mill workers in particular
that resulted in an insufficient diet. The first theory gained popularity with the Southern establishment because it avoided their having to take responsibility for the low wages, the dangerous working conditions, the length of the working day and the slum habitations of the workers in the mills and mines. The infectious theory did have a more respectable group of adherents, i.e., physicians who worked in the age when diseases that had been thought to be idiopathic were found to be caused by microorganisms. The second socio-economic/diet theory, which ultimately proved correct, had no such backers and, in fact, met considerable resistance.

The Thompson-McFadden Commission

Col. Robert M. Thompson of New York and J.H. McFadden of New York, two philanthropists, donated $15,000 for the study of pellagra. The Thompson-McFadden Commission began its work in 1912. Members of the investigating commission were Dr. P.R. Garrison of the United States Navy, Dr. W.J. MacNeal of the New York Post Graduate Medical School and Captain Joseph F. Siler of the Army Medical Corps. Captain Siler had spent a summer in Italy in 1910; there he worked with Dr. Louis Sambon and the British Pellagra Commission. Sambon believed that pellagra was borne by the similium fly. Siler came to agree with Sambon page 41 and his bias undoubtedly influenced the conclusions of the commission.

Spartanburg County, South Carolina was chosen as the site of the investigation because the Spartanburg County Medical Society voted to cooperate with the Commission, while many other physician groups refused and because Spartanburg County was a well-known pellagrous area. “At a dinner meeting of the Spartanburg Medical Society on November 26, 1909, Dr. James Babcock pointed out that pellagra was responsible for a greater number of deaths in the South than any other illness at the time, and that fifty-two percent of the admissions of the Mental Hospital at Columbia were due to pellagra. This address by Dr. Babcock was instrumental in getting the Medical Association, the County Delegation, and a group of cotton mill presidents ‘to induce the United States Public Health Service to establish in Spartanburg a base for the intensive study of the cause and cure of pellagra.’ The Good Samaritan Hospital agreed to share its facilities with the investigators.” page 68
The study of the Commission, performed in Spartan Mill Village in Spartanburg, came to the conclusion that diet among the pellagra victims was a consideration, but not the direct cause of pellagra. The information for the conclusion about the diet’s effect on the cause of the pellagra was based on interviews done by the Thompson-McFadden surveyors. The investigators studied over 5,000 people, including patients, physicians, storekeepers, millers, and others in the Spartanburg area.

The Thompson-McFadden commission found that in a group of incident cases, evidence of a close association with a pre-existing case was disclosed in more than eighty percent of pellagrins. In the six villages that were surveyed and studied, the commission found that pellagra spread from neighbor to neighbor. The reason for this was that in districts where unsanitary methods of sewage disposal had been in use, there was a rise in cases. The investigators of the Thompson-McFadden reported that the main affliction of pellagra victims was an intestinal infection caused by contaminated food.

In their first year of study no satisfactory data was secured relating to the diets of the non-pellagrous portion of the populations, but the tentative conclusion of the Commission was that the observations upon the habitual use of the more common food-stuff between the pellagrous and non-pellagrous portions of the population tended to confirm the belief that there was no relation between the character of the diet and the incidence of the disease.

The Thompson-McFadden Commission came to the conclusion that pellagra spread from a pre-existing base at a center in the six villages studied and the pellagra morbidity was higher in congested communities using surface privies than in less settled districts in which similar methods for the disposal of excreta were employed. The endemic foci of pellagra were located in the districts in which surface privies were in use. In the two cotton mill villages completely equipped with a water carriage system of sewage disposal it was impossible to find cases of pellagra which had originated there, although some cases which originated elsewhere were present. The report found that pellagra was contagious. This coincided with the poor sewage system, or even the lack of a sewage system in the South. It was decided that the stable fly (Stomoxys calcitrans) displayed certain
salient characteristics which seemed to qualify it for the role of a transmitter of pellagra.

J.F. Siler and the members of the Thompson- McFadden Commission summarized their conclusions: 26

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 probable carrier.

Although the conclusion of the Thompson-McFadden Commission was quoted for decades that pellagra was an infectious disease, their study is now ignored or forgotten.

**Spartanburg, South Carolina**

The investigators from the United States Public Health Service followed in Spartanburg probably because they wanted to repeat the studies of the Thompson-McFadden Commission. In any case, Spartanburg had many cases of pellagra and many mill towns. The Good Samaritan was a Public Health Service Hospital built in Spartanburg. It served for almost all of the research that was done on pellagra in the South.

The area of the future Spartanburg, the civic center of Spartanburg County, became accessible to settlers following a treaty with the Cherokee Indian Nation in 1763. Later, the Revolutionary War began and the Spartanburg locale was the site of more battles than almost any other location in the future United States. Once the war ended, settlements sprang up in and around the area and the new district began to take shape by forming its own government. Following the construction of a new courthouse, the town was named Spartanburg after the Spartan Regiment formed at the beginning of the Revolutionary War.

In 1831, the town incorporated and a couple of decades later it became known as the “Hub City” due to the wheel hub shape the many
railroads gave it as they came into the area. Although there were relatively few cotton mills in the area before the Civil War, new technological advances that simplified the work, northern capital, and out-migration from the poor farms created a wave of post-bellum mill development in the Spartanburg area and in much of the Piedmont South. Additionally, the abundant streams and rivers in the area begin their descent toward the lower lying Midlands region. In many places, these waterways descend abruptly, providing a source for plentiful waterpower and so began the region’s servitude to King Cotton. Between the late 19th century and the early 20th century, the textile industry dominated the economy in Spartanburg. Nearly 40 textile mills were built during this time period. In 1895, there were 20 cotton mills with a total of 487,000 spindles and 14,454 looms that were capitalized at $6,110,200. The largest were the Clifton Mills with 100,000 spindles and 3,250 looms. According to the U.S. Census in 1900, 54,434 people were in the employ of the cotton mills of South Carolina. Spartanburg became known as “The Lowell of the South.”

The mill buildings visited by Goldberger’s team were noisy factories where workers turned raw cotton into yarn and fabric. All the production jobs were restricted to whites. The job of ‘fixer’ was the most prestigious, held by men who knew the machinery well. Weavers held prestigious jobs as well because of the artistry involved. Few black faces would be visible. Blacks were confined to menial jobs such as janitor or boiler fireman. Mill hands worked sixty hours a week for wages that varied from 15 cents to $1.25 per day. One mill hand described the situation: “The day’s work begins at 6 o’clock in the morning and runs till 7 o’clock at night. They stop at 12 o’clock for dinner and ring the bell and 12:30 o’clock. I counted that the hands are in action 13 hours per day. The trade system is used here, and is not as good as cash, at this place or any other place. This long hour system is destroying the health of all the young women who work in the mills. The employment of children in the mills at low wages keeps a great many men out of employment.”

We are indebted to the Reverend Clarence Crocker of Glendale, South Carolina for the following story of one of the mill companies in Spartanburg: “The Clifton mill began as the Bivingsville Manufacturing Company which fell into bankruptcy in 1856. It was sold to John Bomer Jr. and associates in a Sheriff’s sale and operated under the name J. Bomer & Company. After Mr. Bomer’s death, the company was re-organized under
its new owners, Dexter Converse and others as the D.E. Converse Company. At the request of Mr. Converse, the Clifton Manufacturing Company was organized in 1880 for the purpose of building a cotton mill plant. In 1881, Clifton Mill #1 went into production; Clifton Mill #2 was built in 1888. The D.E. Converse Company, consisting of two divisions, Glendale Mills and Clifton Mills was incorporated in 1889. In 1890, Glendale added the second plant and Clifton Mill a third plant. Glendale plant #3 was finished in 1902. A flood in 1902 devastated the mills. Homes were washed away and lives lost. The plants were soon rebuilt and expanded.

“The Clifton Manufacturing Company was sold to J.L. Stifel and Sons of Wheeling West Virginia in 1946 and Louis Douglas deLoach became Executive Vice President and General Manager of the operation. He found the mill as well as the village in dire need of upgrading. He immediately announced and started work on a million and a half dollar program of renovation and improvement. The mill was still being powered by a water wheel, turbines and steam engines and was lighted with incandescent light. The interior walls and ceilings of the mill were in dire need of a fresh coat of paint. Improvements began by thoroughly painting the mill’s interior. Fluorescent lights replaced incandescent lights. New or rebuilt machinery replaced outmoded or worn-out machines. Machinery was individually motorized. The water wheel, turbines and steam engines were discontinued and removed. A new electric grid was built proving a more dependable power source for both mill and village. Spinning and weaving additions were added to the plant. A new elevator was installed plus many other improvements.

“Large sewage treatment tanks and drying beds were built behind the mill. The mill sewage, which had emptied into the river for some 100 years, was turned to the collections tanks and drying beds. Sewer lines were installed throughout the village and all village sewage was collected for treatment along with the mill sewage before emptying into the river. Village septic tanks which had been installed in 1917 were discontinued.

“The village houses [had] 4, 5 and 6 rooms with a toilet on the back porch and were in terrible shape. Many, if not most, were more than a hundred years old. Most had only a few coats of whitewash or paint since being built. The bathroom was limited to a water toilet and a laboratory. None were wired for hot water heaters. Many houses were torn down,
some were moved, but every house left standing was completely remodeled with modern bathrooms, hot water and new electric wiring. New windows, doors, siding and roofing was also installed. A new gymnasium was built. The village store was remodeled. After the homes had been totally renovated, they were offered for sell, giving many employees who had never dreamed of owning his or her home, the chance to buy...Mr. deLoach died in 1995.”

We tell the tale of one of the mills in detail because it illustrates the multiple ownership of the mills, the dire state of the mill and the mill villages neither of which had been renovated from 1880 until after World War II.

Life for the average mill worker was far from ideal. Hours were long, the work grueling, and the pay minuscule. Mill village houses were often small, ramshackle structures that lacked running water. Many of those employed in Spartanburg’s textile industry were originally from the mountains of North Carolina and Tennessee. These people viewed life in the mills as a step up from the grinding poverty that existed in the mountains. Still, endemic poverty remained a way of life in Spartanburg’s mill communities.

During World War I a U.S. Army camp, Camp Wadsworth, was erected in Spartanburg at the time a poverty-stricken textile center of approximately 20,000 inhabitants. Thousands of workers were hired to build Camp Wadsworth with their paychecks spent, if not in Spartanburg, then in the surrounding countryside. For the week ending August 11, 1917 approximately 3,000 workmen drew a pay of over $75,000 at Camp Wadsworth. By the end of August the number of civilians working at the site had reached 4,500. The town of Spartanburg was often filled with some of the 30,000 khaki clad soldiers stationed at the camp. Presumably, this scene occurred all over the South, accounting for war time prosperity and the fall in incidence of pellagra during the War.29

Between the collapse of the cotton market and the infestation of the boll weevil, the economy of the South again collapsed after the War. The entire South would be affected by the decrease in cotton production throughout the 1920’s which in many ways brought the beginning of the Great Depression to the South well before the stock market crash of 1929.27
At the conclusion of World War II, the mill life began to decline as wages in other industries rose and the automobile industry boomed during the 1950’s. Remnants of a few of the mills remain along the river banks today, e.g., the Glendale Mill, The Beaumont Mill and the Converse Mill.

The history of Spartanburg and its mills was reviewed because Spartanburg was the site of the investigations of the Thompson-McFadden Commission and the focal point of the studies by Goldberger and his associates.

Lavinder

Dr. Claude H. Lavinder was sent by the Public Health Service to Italy to study pellagra there in 1910. He spent some time with Dr. J.F. Silar who later joined the Thompson-McFadden Commission (above), but did not agree with Silar that pellagra was a contagious disease. Lavinder returned to the United States without an opinion as to the cause of pellagra. He requested that some pellagra patients be brought to Washington for hospitalization and study. Congress approved the admission of pellagra patients to the Marine Hospital in Savannah to be studied by Lavinder and an associate Dr. R. Grimm. However, despite their efforts, they made no progress in their pursuit of the cause of pellagra. Lavinder then went with Grimm to New Orleans where they visited the Tulane University Laboratory of Dr. W.H. Harris who had reported the successful reproduction of pellagra in the rhesus monkey. Lavinder and his associates were unable to repeat Harris’ findings. Meanwhile, Grimm spent years performing field studies. His report was given to the Second National Meeting for the Study of Pellagra and is quoted above. Grimm provided no answers, but he did gather more concrete facts than anyone else had done before.5 page 48-49

Goldberger the Peripatetic

Lavinder then campaigned for a pellagra hospital. It was established in Spartanburg in 1914 “The Good Samaritan Building” located at the corner of College and Forest Streets because no other community welcomed the hospital as this would be an admission that pellagra was present there. By 1914, however, Lavinder had burned out on the project and requested reassignment.6 page 99 The Public Health Service decided to give the problem more support and attention. Forty-one men were put in
the field to study pellagra from every conceivable angle and their work was financed with the sum of $80,000 for the first year. Surgeon General Rupert Blue appointed Dr. Joseph Goldberger to take Lavinder’s place.\(^5\) page 65

Goldberger began by immersing himself in libraries and exploring prevailing theories of pellagra’s etiology in the existing literature. In his notes, in the margins of an Illinois report, he underlined: “The disease impressed us as an intoxication rather than an infection,” and, “At the Peoria State Hospital the diet was markedly deficient in protein constituents and especially in animal protein.” Goldberger read that the Europeans focused on eating only maize as the cause of pellagra, but differed as to whether moldy corn, corn harvested prematurely, or lack of animal protein was a predisposing factor. Goldberger was intrigued by Dr. Casimer Funk, who working in London, discovered that beriberi was due to a protein deficiency that occurred only in those who ate polished rice and that thiamine was the cure.

During 1914, Goldberger visited asylums, prisons, and orphanages throughout the South starting with a three-week tour of southern institutions, including the hospital for pellagrins in Spartanburg, South Carolina, the Georgia State Hospital for the insane in Milledgeville, and orphanages in Jackson Mississippi. As he had done in his previous investigations of other diseases, he hunted for insects that might carry pellagra from patient to patient. However, what struck Goldberger the most was that in all the institutions he visited, not a single staff member had pellagra, confirming the earlier observations by Searcy. In 1915, Goldberger reported on the progress of an experimental study at two orphanages in Jackson, Mississippi and a Georgia state sanitarium. He increased the supply of milk, gave one egg daily to all children under twelve, and served meat three or four times weekly beginning in September. The following spring with this diet, there was only one case of recurrence among the 172 pellagrins from both orphanages, and no new cases of pellagra among the 72 pellagrins at the George sanitarium after the dietary modifications, though the recurrence rate was 50% among the controls. With these studies, Goldberger was convinced that pellagra was a preventable dietary malady.\(^30\), \(^31\) Goldberger presented his findings and his diet theory at the Third Triennial Convention of the National Association for the Study of Pellagra at Columbia South Carolina in 1915 (above).
Despite Goldberger’s studies, many southerners remained adamantly opposed to his findings, that diet determined by poverty caused pellagra because that meant admitting to a stubborn backwardness at just the moment when the South was scrambling for political parity and anxious to seem economically dynamic to outside investors. Also, there remained many physicians who continued to claim that pellagra was a contagious disease.4

Meanwhile, the pellagra hospital at Spartanburg was expanded to include an outpatient clinic. The pellagrins attending received no medication, only food. They came to the clinic daily for dinner. The average patient recovered fully in from six to eight weeks.5

Goldberger’s Controlled Studies

Goldberger, the scientist, realized that a controlled study would be necessary before his fellow scientists and the public would be convinced about his diet theory. Only, if he could begin with healthy individuals and alter their diets under controlled conditions to induce pellagra symptoms might he persuade doubters that pellagra resulted from a faulty diet. Goldberger convinced the United States Surgeon General and Governor Earl Brewer of Mississippi to allow him to conduct the experiment with prisoners at Rankin State Prison Farm, a white penal farm, in 1915. The prisoners there appeared strong and robust without a hint of pellagra, because they ate a “good” diet of meat, buttermilk, field beans, and peas from the prison farm almost daily.

Goldberger and Wheeler reported their experiment planned to test the possibility of producing pellagra in a healthy human, white adult male by a restricted, one-sided mainly carbohydrate diet.32 The experiment was carried out at the farm of the Mississippi State Penitentiary, about 8 miles east of Jackson, Miss. Dr. A.G. McLaurin assured Goldberger and Wheeler that there was no history of the occurrence or presence of pellagra at the farm. Included among the convicts were 12 who, accepting the offer of a pardon made them by Gov. Brewer, volunteered to subject themselves to the experiment.

One of the volunteers was excused because he developed prostitis, leaving 11 who were quartered in a small screened cottage which was then
strictly segregated and under guard day and night. From April 4 to April 19, the men were observed without any change in their diet and none developed signs of pellagra. Goldberger and Wheeler then itemized the diet given to the prisoners which now consisted of biscuits, fried mush, grits, brown gravy, and syrup for breakfast, corn bread, cabbage, sweet potatoes, grits and syrup for lunch, and biscuits, fried mush, gravy and syrup for supper. The entire population of the “camp” was kept under observation as controls.

Of the 11 volunteers, not less than 6 developed symptoms including a “typical” dermatitis justifying a diagnosis of pellagra not later than five months after the beginning of the restricted diet. No person in the “camp” not of the volunteer squad present evidence of pellagra. The diagnosis was concurred by two physicians. Goldberger and Wheeler concluded that pellagra had been caused in at least 6 of the 11 volunteers as a result of the restricted diet on which they subsided.

Several were so miserable that they tried to end the experiment prematurely. One said: “I have been through a thousand hells!” while others pleaded for a quick death from a bullet. On the first of November, 1915, the Rankin prison experiment was ended. Pardons and praise replaced circumspection and secrecy. Newspapers all over the country trumpeted Goldberger’s demonstration that he could produce pellagra in strong, healthy men by depriving them of fresh milk, lean meat, and vegetables.

Goldberger became convinced that he needed to defend the results of his experiments further in the face of opposition from physicians and other investigators who claimed that Goldberger had not eliminated the possibility of the infectious cause of pellagra. In order to throw further and, if possible, conclusive light on the subject of transmissibility, Goldberger enlisted 18 colleague/volunteers (one of whom was his wife) for an experiment and used material from pellagrins who were patients at various hospitals. He injected 5-6cc of blood intramuscularly or subcutaneously of a patient with pellagra in the moderately acute first attack into two volunteers. He obtained nasal and nasopharyngeal secretions from a pellagrin and swapped the mucosa and nasopharynx of a volunteer with this. He fed epidermal scales and urine from two pellagrins and feces from a third, as well as scales obtained by scraping the affected
area of the skin, urine by catheterization and feces with the aid of a simple water enema from pellagrins in the hospital. No volunteer suffered side effects. He repeated the experiments on five volunteers. There were no side effects excepting an enlarged lymph gland in a drainage site in one subject after the injection of blood and one attack of rather severe diarrhea in one volunteer after the injection experiment. Another experiment was a repeat of the ingestion of urine and feces of a pellagrin by five volunteers one of whom developed abdominal discomfort and “abnormal gaseous evacuation” which lasted about two weeks. The final experiment consisted of three volunteers swallowing a mass of urine and feces mixed with flour. Some of the volunteers again developed dyspepsia and diarrhea after ingesting the feces/urine mixture.

Goldberger noted: “Aside from the immediate, temporary disturbances none of the volunteers had experienced any appreciable effects...During a period of between five and seven months none has developed evidence justifying a diagnosis of pellagra...These experiments furnish no support for the view that pellagra is a communicable disease. They strengthen the conclusion that it is a disease essentially of dietary origin, brought about by a faulty, probably ‘deficient’ diet.  

Goldberger faced a cacophony of criticism for his experiments on prisoners and fellow investigators from physicians in and of the South, e.g., Goldberger used too few subjects; Goldberger implied that the South was starving its people; Goldberger’s experiments were likened to medieval torture, etc. Etheridge did not cite one complaint about the ethical problems with the experiments and Kraut mentions a few recent criticisms in passing. This seems somewhat shocking to the present-day reader, sensitized by German concentration camp experiments on inmates, the Tuskegee and Honduran syphilis experiments and the “Acres of Skin” experiments carried out by Dr. Albert Kligman on Holmesburg prisoners.

In any case, in 1915, Mississippi saw the number of cases of pellagra rise to 15,831 about 10 percent of whom died. The estimated annual cost of the disease was over two million dollars. Mississippi embraced Goldberg’s recommendations of an adequate diet, launching a public education campaign, erection of county pellagra hospitals, and hiring physicians as field men to make house-calls.
The U.S. Public Health Department Team

In 1916, Goldberger and Dr. George Wheeler of the Public Health Department and Edgar Sydenstricker together with a team of workers was assigned by the U.S. Public Health Service to determine why pellagra was so prevalent in the South and why only certain southerners were stricken. Goldberger and Wheeler and their team would do the field work, while Sydenstricker and his would perform the statistical analyses. Edgar Sydenstricker (1881-1936) was a Consulting Statistician of the United States Public Health Service. He had previously studied the working and living conditions of industrial workers and the relation of economic status to the health of garment workers in New York City. Edgar Sydenstricker was from the same family as V.P. Sydenstricker mentioned here. Sydenstricker would be in charge of the relation of dietary, economic and sanitary factors to the prevalence of the disease in cotton-mill villages.8, 34, 35

In 1920, Goldberger, Wheeler and Sydenstricker wrote a long article filled with tables, charts, lists, statistics and sentences which are difficult to decipher, that described the work of the Public Health team in 1916.35 In planning the study, “it was our purpose to make as accurate observations as possible relating to the diet, the economic conditions and sanitary environment of a population in which pellagra was endemic and to correlate the result with the incidence of the disease in this population.” The team chose to study seven cotton mill villages in South Carolina because no southern state was more committed to cotton milling than South Carolina which was only second to Massachusetts in number of spindles; 12.6 percent of its white pollution were cotton mill workers and because they could compare their study and conclusions with those of the Thompson-McFadden commission who had worked there. Also, the seven cotton mill villages could be easily reached from Spartanburg where the United States Public Health Service had established a hospital for the study of pellagra.
In Spartanburg County, workers’ lives were closely bound to the mills and they lived in mill villages in company housing. Southern mill owners built cheap cottages in the villages with two, three or four rooms or duplexes with eight rooms that could be used by two families. Family housing was important because usually all members of the family including the children worked at the mill. Supervisors and black workers lived in separate neighborhoods from white wage earners. The team collected data on 4,399 individuals, among them were 155 definite cases of pellagra, a rate of 26.1 per 1,000. In a number of cases the rash was ill-defined. If these 73 suspect cases were recorded, the total would rise to 188, an incidence rate of 72.7 per 1,000.

The team found that basically the diet of the nonpellagrous households and that of the pellagrous households were much the same except that the nonpellagrous households had a greater supply of animal protein foods (lean meat, milk, including butter and cheese). The addition of milk and animal protein meant to the investigative team that nonpellagrous families had an adequate supply of essential amino acids, of minerals or some of its constituents and/or some unknown essential vitamin. They found no correlation between varying supplies of maize meal, wheat flour or the common legumes and pellagra incidence which offered no support for the Zeist theory of the etiology of pellagra. The diets of the pellagrous households had a smaller supply of vitamins than the nonpellagrous households particularly the “fat soluble A” factor.
Women over the age of 20 developed pellagra eight times as frequently as men. Pellagra seemed more prevalent at certain times of the year. They found that the incidence of pellagra began to rise in the late winter or early spring reaching its apex in June and then tapered off in the summer and autumn. Each household was canvassed for fifteen days because Goldberger and Sydenstricker believed that such a period would give a sufficient sample of the supply of food of the season immediately preceding the peaks of the seasonal incidence of the disease. They thought that something in the “pellagra producing diet” changed in the spring, but did not mention a possible photosensitization factor.

There was no evidence obtained by the team that pellagra was contagious. For example, the team found no relationship of pellagra to typhoid incidence. Whether clean or dirty, water quality was not related to pellagra incidence. Their results afforded no support for the view that pellagra was an intestinal infection transmitted in much the same way as typhoid fever.

From April 16 to June 15, 1916, a staff of trained enumerators under the direct supervision of Sydenstricker collected dietary and economic data from approximately 4,160 individuals in 750 households. They asked villagers about family income, household food supply, and the composition of households. As Sydenstricker and his enumerators went about their business, they saw with their own eyes that poorer folks got pellagra and that often in poor households more than one member came down with the disease.35

Sydenstricker had written a report on the relationship of pellagra to a rise in the cost of food in 1915.34 He concluded: “(1) The lower the economic status of the family the greater is the pressure for sacrifices in diet particularly in animal protein foods which are the most expensive. (2) The economic status of the wage earners’ families in the Southern States, particularly of cotton mill families, is lower than wage earner’ families in other sections of the country. (3) The proportion of proteins in the diet of southern families is considerably less and of carbohydrates and of hydrocarbons considerably greater than in the diet of northern families. (4) The industrial depression of 1907 lowered the economic status of wage earners’ families especially in the cotton goods and lumber industries because of lower wages and unemployment and the increase in cost of
food with the increase 40 percent higher in protein than in carbohydrate and hydrocarbons. (5) The available data thus pointed to a lessened financial ability of southern wage earners’ families to provide a properly balanced diet of animal protein food supply particularly since 1907 or 1908.”

Goldberger, Wheeler and Sydenstricker and Goldberger observed that the proportion of families affected with pellagra declined with a marked degree of regularity as income increased. This inverse correlation was even more marked in cases where there was more than one case of pellagra in the family. The more modest the income, the smaller amounts were purchased of all meats with the exception of salt pork. So, too it was with green vegetables, fresh fruit, eggs, butter, cheese, preserved milk, lard, sugar, syrup and canned foods. When the extremes of income were examined, it appeared that the supplies of wheat flour and bread and of fresh milk were appreciably smaller in the poorest households.

**Summary of the investigations of the U.S. Public Health Team**

- The abject poverty and squaid living conditions shocked the investigators. The degree of poverty with the resultant inability to purchase adequate food determined the incidence of pellagra.
- Dietary insufficiency was associated with the incidence of pellagra, but the specific dietary lack eluded the investigators.
- The amount of corn eaten was not important, but the lack fresh meat, poultry and eggs was.
- 2.6% to 7.3% of villagers developed pellagra depending certainty of diagnosis.
- Females from the age of 20 developed pellagra eight times as frequently as men.
- The onset of pellagra occurred during the spring and summer months.
- Pellagra was not contagious.

Why did pellagra suddenly appear when the diet of the Southern poor had remained the same before and during the epidemic? Of course it had not. When living on small farms the poor of the South had access to a cow, pigs and wild game as Wheeler found in his study of Yancey County.
However, a change in the diet coterminous with moving to mill villages did occur.

**Incidence of Pellagra in the United States**

All who have written of the incidence of pellagra and deaths due to it in the United States warn that the statistics are unreliable because of faulty census taking, overlapping, rough estimates of morbidity and mortality and because many communities denied the existence of the disease because of the shame and fear associated with it. Nevertheless, all agree that at the turn of the 20th century pellagra became a real disaster in the southern states, no matter the statistics. The disease was rumored to spread through the mill villages like wildfire. People feared the disease was contagious and linked pellagra to plagues described in the bible. The fear was so great (pellagra phobia) that an article appeared in the Spartanburg Herald on January 10, 1914 asking for land to be set aside to build a farm for pellagra victims, in an attempt to quarantine them from the population. The article suggested that pellagra victims be isolated, where they could grow their own food and their bodily waste be disposed of properly. Below the raw data culled from the available literature are listed.

There were 10,000 cases of pellagra in the United States in 1911. Records for 1907-11 for eight southern states revealed 15,870 cases, with a fatality rate of 39.1 percent (Transactions of the 2nd National Conference on Pellagra). The incidence of pellagra increased greatly in the early 20th century, during the Progressive Era. In 1909, more than 1,000 estimated cases were reported from thirteen states. By 1911, pellagra was reported in all but nine states, and the number of cases increased nine fold.

South Carolina recorded 30,000 cases of pellagra by 1912 with a fatality rate of 40%. In 1915, the estimated number of total cases had reached 75,000. During the period from 1915 to 1925, the first decade of reporting, 27,648 deaths from pellagra were recorded in the U.S.A. House-to-house surveys from 1915-1925, seeking unhospitalized cases, suggested that there were at least 35 non-fatal cases for each death. On the basis of that estimate, a total of 967,000 cases of pellagra occurred during those ten years alone. By 1929, the incidence of pellagra reached its
all time high. That year the reported deaths exceeded 7,000 and in 1930 there were probably more the 200,000 pellagrins in the U.S.\textsuperscript{2}

During the ten-year period of 1920 to 1930, many thousands of deaths were reported yearly, with a peak in 1928 (6969 deaths).\textsuperscript{19} In 1930, in the state of Georgia alone it was estimated that there were 30,000 patients suffering from pellagra\textsuperscript{38} and 432 deaths.\textsuperscript{39} Between 1907 and 1912, an estimated 25,000 cases had been diagnosed with a mortality rate of 40%.\textsuperscript{40}

The statistics gathered by the group from the National Center for Health Statistics of the US Department of Health and Human Services cited the \textit{Vital Statistics of the United States}, the states and the United States death registration system. Information on federal regulation of grain products was obtained from the \textit{US Federal Register}. Information on state fortification activities was obtained through literature and personal communication with state governments. Annual national per capita disposable income in 1987 dollars was obtained from the Bureau of Economic Analysis of the US Department of Commerce. Using SAS procedures they analyzed the relationship between various contributing factors and the decline of pellagra for the years 1933 to 1950. They limited statistical analysis to these years because information on pellagra deaths was not available for all 13 southern states before 1933 and pellagra was under control by 1950. Niacin was identified as an anti-pellagra agent in 1937. In 1942, a federal regulation for enriched flour became effective. The authors compiled “cumulative fortification scores” to examine the relationship between food fortification and the pellagra rate.\textsuperscript{19}

“From 1933 onwards when information became available (and in all probability from 1900 onwards) almost all deaths from pellagra came from 13 Southern States: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia. The number of deaths from pellagra peaked at about 7,000 in 1928 and then began to decline. There were two distinct periods of rapid decline, one between 1928 and 1932 and the other beginning in 1939. The most likely explanation for the dramatic decline in mortality between 1928 (3,500) and 1932 (3,100) in the 13 Southern States is probably related to the fact that by the mid-1920’s several anti-pellagra foods such as milk, eggs, meat and yeast had been identified although the
cause of pellagra, i.e., deficiency of niacin, was still unknown. Yeast was extensively distributed by the Red Cross beginning in 1927 following flooding of the Mississippi River and it spread to the adjoining states and throughout the South. As the economic depression continued and less money was available for the purchase of yeast distribution was curtailed and this caused a plateau in pellagra mortality in the mid 1930’s.

“The second large decline in pellagra mortality started in 1939. Several factors that would be expected to reduce pellagra deaths occurred around this time. These factors included fortification of grain products, increased availability of animal-derived foods, improved treatment, and a recovering economy. The effectiveness of the mandatory enrichment program is clearly seen in Mississippi. Following the initiation of mandatory enrichment of bread, flour, cornmeal and corn grits in that state, the pellagra morbidity dropped precipitously, from 101 per 100,000 in 1946 to fewer that 1 per 100,000 in 1947.  

\[19, \text{Fig. 1 page 728}\]
“The relative importance of improved economic status vs. food fortification in the eventual elimination of pellagra in the United States has been debated for years. Proponents of the economic theory have suggested that economic growth would bring about changes in dietary patterns, leading to better nutrition and that pellagra was already decreasing before the federal and state fortification movement began in the early 1940’s. However, the data presented here is not consistent with that hypothesis. The first major decline in pellagra mortality occurred concomitantly with the economic depression of the late 1920’s and the early 1930’s, contrary to what the economic theory would predict if the distribution of brewer’s yeast were not considered...The results of our statistical analysis showed a strong correlation of food fortification with the
decline in pellagra mortality and morbidity after other influencing factors were adjusted for."\textsuperscript{19}

Thus, the studies of Park et al were probably the most accurate of all reports concerning the morbidity and mortality of pellagra. They reported that between 1900 and 1907, there were 0 to 2 reported deaths from pellagra each year. By the mid-1910's, the annual number of deaths surpassed 1,000. The number of deaths from pellagra peaked at about 7,000 in 1927 and then began to decline. There were two distinct periods of rapid decline, one between 1928 and 1932 and the other beginning in 1939.\textsuperscript{19, Fig 2, page 729}

\textit{Pellagra deaths and per capita disposable income in the United States from 1929 to 1955.}

Park et al Fig 2, page 729
During 1928, at its peak incidence, pellagra was the eighth or ninth leading cause of death besides accidents in the South where deaths from those states represented about 90% of the total death from pellagra in the United States. Economic recovery and the enrichment of flour with niacin as well as improved diet and health in areas where pellagra had been common were the factors that made possible the elimination of pellagra by the end of the 1940's.

Incidence and mortality statistics from the state of South Carolina recorded 30,000 cases of pellagra by 1923, with a case fatality rate of 40%. From 1915 to 1925, the first decade of systemic reporting, 27,648 deaths from pellagra were recorded in the U.S.A. Reported deaths exceeded 7,000 between 1928 and 1930; there were probably more than 200,000 patients suffering from pellagra at this time. Thus, the pellagra epidemic lasted for over 30 years from 1904 to 1940. It resulted in an estimated three million cases, with at least 100,000 deaths in the reporting states.\textsuperscript{4,37}

Between 1928 and 1940, the rates of pellagra were about 6 to 15 times higher for non-Whites than for Whites and higher for females than males. The ratio decreased with time for women, but after 1928 it was relatively stable for men.\textsuperscript{19} For both races, about twice as many females died from pellagra as did males.\textsuperscript{41}

From the plethora of statistics quoted above, most estimated, many contradictory and other probably biased, we can draw the following broad conclusions:

- Pellagra was unknown in the United States until the end of the 19\textsuperscript{th} and the first decade of the 20\textsuperscript{th} century when the southern tenant and small holding farmer left, voluntarily or not, the farm for the new mill villages and mines of the South where the living conditions were often desperate and the diet inadequate.
- From 1900 until the beginning of World War I the incidence and mortality of pellagra exploded.
- During World War I pellagra became less common because of the war prosperity and because many of the men either worked in military bases or were in the Armed Forces and received a salary some of which could be sent to their families.
In the early 1920’s the incidence of pellagra increased dramatically because of the depression of 1920-1921. Although the 20’s might having been roaring for some of the wealthy in the North, the southern the cotton economy collapsed and the boll weevil infestation ruined the crops.

Beginning in 1929 and 1930, the incidence of pellagra began a rapid decline because brewer’s yeast was distributed widely by Public Health Nurses and the Red Cross.

The incidence of pellagra plateaued from 1935 to 1939 because of the “second depression” and the lack of interest in distributing brew’s yeast. However, it did not reach its previous rate because of the policies of the New Deal.

In 1939, the fortification of food, particularly bread with niacin together with improvement in economic conditions, brought a precipitous decrease in incidence and the disappearance of pellagra in the United States.

The Rise of Cotton Mills in the South

The explosion of Southern Cotton mills occurred simultaneously with the pellagra epidemic there and pellagra occurred most commonly in cotton mill villages. Therefore, the rise of cotton mills of the South should be studied and understood. Mitchell Broadus wrote a thesis on the rise of cotton mills in the South which included an understanding of the weltanschauung of the post-reconstruction era. The following is a loose and selective quotation of that work.42 He wrote that to understand the establishment of cotton mills in the South, it is necessary to grasp the deeper impulses which actuated every policy, certainly from the year 1880 onward and continuing in only modified degree to the present (1918). Every phase of the movement for the building of cotton mills was conditioned by motives at once tender and heroic, universal in their applicability and too intimate in appeal to admit of more than passing argument. In a study of the actual erection of factories, the hundreds of problems that arose and the mass of practical detail attendant upon their solving constitute a hopeless or at best profitless puzzle, unless it is clearly understood that these point back to something elemental and primal which gave them character.
On the other hand, if this fact is recognized, the circumstances which accompanied the setting of mills in operation, such as the securing of capital, the obtaining of adequate labor, the selection of sites or the locations of buildings and the like, from the very coldness of the subjects, and the unsentimental aspect as commonly thought of, strike into peculiarly bold relief the purposes that lay behind them. When it comes to money-getting, psychical factors must be crystallized into something very forceful and admitting of unquestioned faith. This responsible cause, catching a phrase from a writer of the day may be termed “real reconstruction.” The impulse for it came over the South in 1880 like a great ground swell, translating itself into a thousand activities and ramifications. “Real reconstruction” was spectacularly the outcome of the defeat of Hancock by Garfield in the presidential election immediately, (In 1880, Garfield, a Republican, beat Hancock, a Democrat and an heroic Civil War General, by 7,368 votes out of neatly 8.9 million cast.) but its roots run deeper and have their hold in the slow but sure recuperation of the South from the devastation of the Civil War through the troubles of radical rule, assisted by a brief breathing space from the termination of carpet bag government in 1876, when the lesson of fifteen terrible years soaked in thoroughly. In 1880, the South suffered a change of heart, a revulsion of conscience that was fundamental. The people turned on their heels, and faced about to find a new future of the largest promise.

The *Raleigh News and Observer*, a newspaper which before had bent every effort toward the election of Hancock, the Democratic candidate for the presidency, as securing for the South political independence and revenge for Northern mistreatment, a week after his defeat in 1880 printed an editorial titled “Our Refuge and Strength” with these words:

“...we have been defeated in the national contest. In the administration of the national government for the next four years we need not concern ourselves, for as far as possible our councils will be ignored. What, then, is our duty? It is to work earnestly to build up North Carolina. Nothing is to be gained so long as we go to the North for everything from a tooth pick to a President. We may plead in vain for a higher type of manhood and womanhood among the masses, so long as we allow our children to grow up in ignorance. We may look in vain for the dawn of an era of enterprise, progress and development, so long as thousands and millions of money are deposited in our banks at four percent interest when
its judicious investment in manufacturing would more than quadruple that rate, and give profitable employment to thousands of our now idle women and children. Out of political defeat we must work a glorious material and industrial triumph. We must have less politics and more work, fewer stump speakers and more stump pullers, less tinsel and show and boast and more hard earnest work. We must make money – it is power in this practical business age. Teach the boys and girls to work and teach them to be proud of it...Demand all legislative encouragement for manufacturing that may be consistent with free political economy. Work for the material and educational advancement of North Carolina. In this, and not in politics, will be found her refuge and her strength.”

Broadus goes on to write that the uselessness of attempting a political salvation as contrasted with the logic of giving all energy to the building of the South materially occurs again and again in newspaper interviews and editorials, e.g “Business is driving sentimental politics to the woods.” “The Southern people, outside of professional politicians, care very little about politics. They are endeavoring to develop the resources of the South and regain the broken-down fortunes left by the desolation of the Civil War.” “If we lost the victory on the field of fight, we can win it back in the workshop, the factory, in an improved agriculture and horticulture, in our mines and in our schoolhouses.” Broadus continued that in the broken and all but disheartened condition of the South after enduring the war, radical rule and defeat of political hopes, this conception of another economic future, once it burst upon the consciousness of the Southern people, amounted to nothing less than a religion. When the Charleston Manufacturing Company began to sell shares, the Charleston News and Courier enthusiastically supported the effort noting: “Presently, Charleston does nothing to increase the value of the cotton which comes here for sale. Cotton mills change all this. A bale of raw cotton worth forty dollars is spun into yarn worth eighty dollars...The stockholders and the working peoples get the whole difference between the cost of the cotton and the value of the yarn or cloth.”

According to Broadus, the ‘cotton mill campaign’ ensued. In 1880, the U.S. was recovering from the panic of 1878 with a revival of business and prosperity. The South had money, proximity to cotton fields, cheap labor, unused water power, abundance of wood and coal nearby, a favorable climate, absence of damage to cotton by compress, saving in
bagging and ties, assistance to be given to women and children much in need of work, in short, why not cotton mills? “In the beginning and in essence continuing to the end, the building of cotton mills was a sectional matter. It is not to be said that outside capital was an afterthought with the promoters of Southern cotton mills, but every circumstance surrounding the movement, and every instinct of the hour, argued for the exhaustion of native recourses before help should be sought from without. This is not to deny that raising capital locally was an easy task. Newspapers constantly encouraged investment in the mills...The galling fact of bank deposits lying relatively idle when they might be used to further the plans held so much at heart was made more galling where a venture properly launched, stood still because the moneyed peoples held themselves aloof.” When the Columbia Water Power Company opened subscriptions to their capital stock, the News and Courier endorsed the sale because of the value of the franchise, the offer by the state of more than 146,000 days of convict labor at low wage, the rebate of taxation on plant and improvements for ten years, estimated earnings of 17 percent, the influx of immigrants and the employment of thousands of idle women and girls, already present.

Schultz and Tischler do not agree with Broadus that the “real reconstruction” was an awakening of the South to its industrial possibilities inspired and financed by Southerners. They write: “That for all the talk of the ‘New South,’ for all the movement from farm to factory, in many respects the South was not a ‘New’ South by 1900 – at least it was not an economically independent entity as many Southerners had hoped to create. In virtually every economic sphere, in tobacco, in iron, in cotton, in a variety of other activities, Northern investors between the 1880’s and about the turn-of-the-twentieth-century, achieved control...We can even argue that by 1900, the South, in many ways, was as much or more a colonial economy of the North than it had been when the war broke out in the early 1860’s...Economically, if possible, the South by 1900 was more dependent than ever before upon the North. And so, economically, despite the changes that had occurred, the New South was only the Old South wearing a new uniform.”
In any case, the cotton mills got built. In 1900, North Carolina had 177 cotton mills and 40 wool mills, South Carolina had 80 cotton mills and Georgia had 67 cotton mills. The primary advantage for the South over the New England mills and which explained the explosion of the southern cotton mill was written in an editorial of *The Manufacturer and Industrial Gazette of Springfield Mass*: “The Southern States have the advantage of cotton locations, and, when they have secured new and improved machinery, will outdo any rivaled business. They can save freights, buy cheaper and hire cheaper labor. They save buyers, commission, and warehouse delivery and cartage, sampling, classing, pressing, shipping, marine risks and freight and cartage to interior towns, which amount in all to seven dollar per bale. The Northern mills also lose from receiving cotton poorly ginned, containing a good deal of leaf and sand, which is computed at six percent of the entire crop. The difference between the cost of a bale sent to Fall River, Mass., and a bale sent to Columbia, Ga. is eight dollars and six cents. This makes a tax of eighteen percent which Fall River pays in competition with Columbia. It is estimated that, if the planters could manufacture their cotton near home, they would save $50,000,000 in transportation.”
Working Conditions in the Cotton Mills of the South

The complicated processes of turning raw cotton include fluffing of the raw cotton by machines, sucking of the cotton through vacuum tubes to the picking room where pickers clean the cotton and carders feed it into the carding machines where metal teeth pull the mass of fluffy fibers apart to form a long rope (the sliver). The slivers are spun to make a thread. The employee “spinner” (usually girls) watch the process. If the thread breaks, the spinners have to quickly “put up the ends” by twisting the ends of the broken fibers and feeding it back into the spinning machine making a bobbin. Doffers (boys) remove the bobbins when filled and replace them with empty ones. After being spun, weavers working at looms produce the cotton fabric. “Sweepers” (boys) use their brooms to sweep the cotton from the floor of the mill. The work was uncomfortable and dangerous. Doffers and spinners had to climb the machines to reach the bobbins or broken threads. An overseer told Lewis Hine, “Once in a while a finger is mashed or a foot, but it don’t amount to anything.” The accident rate for children was twice that of adults. The combination of the deafening noise, steamy heat in the mill and the lint and dust particles that covered everything including the worker’s caused breathing difficulty early on and lung diseases such as byssinosis (brown lung) and tuberculosis later. A boy in a cotton mill was only half as likely to reach twenty years of age as a boy outside the mill. Girls had even less chance. “In 1911, more than two million American children under sixteen years of age were a part of the work force. Many of them worked twelve hours or more a day six days a week for pitiful wages under unhealthy and hazardous conditions...Small girls tended noisy machines in the spinning rooms of cotton mills, where the humid, lint-filled air made breathing difficult. They were kept awake by having water thrown in their faces...if people could see for themselves the abuses and injustice, surely they would demand laws to end those evils. Hine’s pictures of sooty-face boys in coal mines and small girls tending giant machines revealed a shocking reality that most Americans had never seen. Hine found kids at work in every part of the country. Textile mills were big offenders, especially in the South, where one mill worker in four was between the ages of ten and fifteen. No one knew how many workers were younger than that, because they weren’t counted. ‘I found two little sisters spinning whose grandmother told me they were only six and seven years old. I found two boys under twelve whose hands had been mutilated in the
mill. And I found any number of ten- and eleven-year-old children working an eleven-hour day [during the school term].”  

One of the spinners in Whitney Cotton Mill. She was 51 inches high. Has been in the mill one year. Sometimes works at night. Runs 4 sides – 48 cents a day. When asked how old she was, she hesitated, then said, “I don’t remember. I’m not old enough to work, but I do it all the same.” Out of 50 employees, there were ten children about her size. The overseer said apologetically, “She just happened in.” She was working steadily. The mills seemed full of youngsters who "just happened in" or "are helping sister." Newberry, South Carolina (Hine: The History Place)
Girl, weaving. Note how close she is to the whirling wheel. (Lewis Hine)

Doffer boys, removing bobbins. (Lewis Hine)
Saxon Mill in Spartanburg, SC in May, 1912
Eddie Norton worked as Sweeper.
Hine, Lewis Wickes, 1874-1940, photographer
Photographs from the records of the National Child Labor Committee
Library of Congress
Prints and Photographs Division Washington, D.C. 20540 USA
Myrtle Bagwell, one of the youngest spinners in Spartan Mills, Spartanburg, S.C., standing on porch steps. Lewis Hine, photographer. Photographic print. 1912 May. Her grandfather bought her the dress for her first day at work in the mill. He wanted her to look presentable.

Reproduction number: LC-USZ62-90638 (b&w film copy neg.)
Here is the diary of a Spartanburg woman whose great-grandfather worked in the Beaumont mill. “They [the mill owners] began to recruit workers from the rural and mountain areas around their mills. Providing housing, company stores and community churches was very appealing to hardscrabble farmers with large families. The Piedmont of South Carolina had been farmed to death and without the knowledge or financial ability to farm responsibly by using fertilizers and terracing to stop erosion; the soil became more and more depleted. It produced less and less. In the Appalachian Mountains, not everyone owned good bottom land to farm. Large farms were divided by children by inheritance and it kept getting subdivided. Land had been plentiful and cheap, but the more people that moved into an area, the less land was available for farming.

“Families living in the mountains were living pretty isolated lives too. Not many schools, towns or ways to communicate outside the area meant children were raised illiterate, dirt poor, and not knowing anything of the world around them. Thousands of people were destitute after the War of Northern Aggression. The years of re-construction did anything but re-construct the South. Poverty was palpable. But the Industrial Revolution brought them new hope. The mills recruited them and brought them in. These peoples had more freedom and independence in their agricultural life and were used to being outdoors. Seemingly, the mills sounded good, but they really traded one problem for another.

“Taking these people and placing them in rows of primitive houses, ringing bells for start and stop shifts, crowding them into huge buildings with horrendous noise and cotton lint flying thickly in the air was a real culture shock. Some of the mill owners were better than others. The bad ones let their greed determine the treatment of their workers. Some called it paternalistic as if the workers couldn’t think or act for themselves. And that was the best part of the situation. Others called it industrial totalitarianism. Owners and bosses could be tyrants and workers had little choice but to take it. They had to provide for their families. And many times they got into debt to the company (especially the company store) and couldn’t leave. It wasn’t much better than slavery had been.

“Conditions could be squalid and filthy, and children were forced to work. All were made to follow the rules inside and outside the mill or be threatened to lose everything they had. But then they came from destitute
poverty, squalid log cabins and children had always been forced to work in one way or another. Mill owners would point to their attempts to prove the basic necessities of life for their workers. For instance, the Beaumont mill villages had one church in which the mill contributed to more than three quarters of its cost. The mill kept the church repaired, supplied the fuel and paid the church $50/year. The mill also contributed a teacher to the village’s school. In 1907, Beaumont had 20,237 spindles, 253 looms and consumed 8,000 bales of cotton to produce $450,000.00 worth of cloth and yarn.”

An extensive history of the southern cotton mills that includes photographs of Louis Hine, oral stories of the mills, child labor in the cotton mills, the mill villages and efforts at reform can be accessed on the internet: “Stories of the American South: Child Labor in the Cotton Mills, UNC University Libraries.”

The Fate of Organized Labor in Southern Cotton Mills in the Early 20th Century

Melton Alonza McLaurin wrote of the relation between the Southern textile mill workers and owners during this epoch. The salient points of his arguments are quoted or summarized.45

The image of the Southern cotton textile worker as a docile and tractable laborer created and carefully cultivated by promoters of the New South, by state government agencies, by mill owners and by labor historians of the era from 1875 to 1905 – a quarter of a century during which the South’s cotton textile industry developed and grew – is inaccurate.

Considering the power of management and the weakness of the cotton mill worker, it is remarkable that any response to unionism developed among the South’s mill hands in the early stage of the industry’s development. Labor faced the handicaps of the operative’s illiteracy, his lack of industrial tradition, his fear of Black competition and his inclination to accept the traditional Southern agrarian values. Although management professed unity with the white mill hand, “we’re all one family,” management carried the baggage of the memory of Reconstruction and its
threat to white Southern world view with an abiding fear and hatred of the North. Management thought that it had saved the New South and should be rewarded. Finally, the owners of the mills, like owners of businesses, manufacturing plants and commercial enterprises in both the North and South were primarily interested in making money. They saw collective bargaining as a threat to that bottom line. Management employed the lockout, the blacklist, eviction, the threat of Negro labor and blatant intimidation to forge the weapons with which it successfully resisted unionization until well into the twentieth century.

Nevertheless, isolated strikes did occur even before the coming of the Knights of Labor. The Knights struck hard at the concept of the docile, anti-union mill hand and, for the first time, caused management to fear the economic power of the operatives. The Knights efforts proved that the Southern mill hand, especially in urban areas, would respond to an organization which he felt would improve his condition. Forced into the mills by economic necessity, the operative slowly began to adjust to industrialization and to attempt to improve his newly acquired position.

McLaurin emphasized a factor that contributed to the rise of the cotton mill and often overlooked by historians of the industry; the availability of cheap labor due to farm tenancy. Faced with a shortage of cash, the Piedmont farmer turned to small town bankers and merchants for loans or for credit for supplies. The bankers and merchants advanced money only on the promise to plant King Cotton. The natural results of such a system were continually increasing cotton crops and continually falling cotton prices. The farmer soon became so indebted that foreclosure became inevitable, and the farm passed over to the lien holder, the yeoman farmer slipping into tenancy. With the resultant suffocating squalor and poverty, the people of the Piedmont, chained to the treadmill of the crop-lien system, welcomed the avenue of escape provided by the mills. Also, the inventions of the Sawyer ring spindle doubling the speed of machinery, the development of the humidifier and temperature regulation reducing the breakage of the yarn and the invention of the automatic loom not only decreased the hours of labor necessary to produce larger amounts of cloth in the same time as before without an increase in wages, but also lessened the need for skilled labor. Thus the Southern manufacturer was able to combine the technological advances within the industry with the
immense supply of unskilled labor in the Piedmont resulting in considerable production-cost advantages for the South.

Various factors led to the employment of woman and children in the mills. The number of adult males working in the mills was pathetically small, always less than 50 percent because women and children could be hired for less wages (children on an average of 35 cents a day, women for about 40 cents a day and men perhaps $1.00 to $2.50 daily), because the small, quick hands of woman and children were much more adept at mending broken threads than men and because children and women were easier to train. Many fathers became loafers living off their families. Others attempted to maintain their pride by becoming the family’s errand boys and handymen. Nevertheless, at the end of the day, most mill families had a better economic and social life, as meager as it was, working in the mill than they had on the farm. Thus they remained mill workers.

James L. Orr, the president of Piedmont mills wrote a colleague: “I do not dread the labor law for hours as much as I do for ages. A law prohibiting the working of children under 16 years old, would increase the cost of productions about 25%, and if the age were fixed at 14 the cost would be increased by at least 10%...From 12 to 16 they make the best spinners and doffers and I don’t see how we could get along in the Spinning room without that class.”

Low wages, long hours and squalid living conditions were the main grievances of the Southern operatives. However several relatively minor factors contributed to the hostility between management and labor, e.g., resentment of the native operators of overseers and superintendents many of whom were Yankees, lies of recruiting agents and employers and passing lists of workers to other mill owners to prevent workers from moving from mill to mill.

McLaurin then discussed the efforts of the Noble Order of the Knights of Labor and the National Union of Textile workers to unionize mill workers. The Knights were the major labor union during the 1870’s and 1880’s. Under their Grand Master Terence V. Powderly, the Knights were more a fraternal order than an industrial union or federation of industrial unions. The Knights refused to accept the role of the worker in a modern industrial society. Rather, the Knights rejected outright American industrialism’s reduction of the laborer to an economic entity and sought to
destroy the wage system. The Knights hoped to return to the productive system of the past in which the producer was his own employer, capable of feeling an identity and a sense of pride in the product he produced.

Powderly inveighed against the strike, believing in cooperation (education of the worker) and arbitration. But, as McLaurin pointed out: “Arbitration was impossible as long as the employer refused to recognize the locals. In the face of the opposition that the Knights often met arbitration became a joke.” After a four year boom period, by late 1884 and early 1885, the Southern cotton industry was feeling the effects of the depression of 1883 and Southern mill hands turned to the Knights for protection, establishing locals in some states. They led their one and only strike at the Holt mills in Almance County, North Carolina in 1887. The strike ended in failure.

In 1886, state legislatures began to pass bills hindering labor’s organization efforts and courts convicted ever larger numbers of union members of conspiracy and rioting. As a means of self-protection, labor turned to political action. Despite Powderly’s policy of caution non-partisanship, the local Knights backed John Nichols who was elected to Congress. After their victory in the Nichols campaign, the Knights state assembly met in Raleigh in January 1887 and decided to lobby for a state ten-hour-day law, a child labor law and the creation of a bureau of labor. These lost except for a bill establishing a bureau of labor, a hallow victory for the Knights. In 1888, the Knights nominated an entire slate for state office in North Carolina. All their candidates were defeated. The defeat proved to be the coup de grâce for the order in North Carolina’s textile mills.

They suffered defeats at various mills in South Carolina, including the Clifton Mills just outside Spartanburg. In 1887, the Knights sought recognition of their right to organize the same Clifton mills. Management began to discharge members and they struck the plant. All Knights, real and imagined were locked out of the mills and eviction proceedings were started against the families of Knights from company housing. The strike failed. McLaurin tells in great detail a strike against Augusta mills led by a charismatic Reverend J. Simmons Meynardie, a Baptist minister. The strike failed. The Knights of Labor had been driven from Georgia’s and the South’s textile industry. Despite its failure the Knights were the first labor
organization to challenge the hitherto sacrosanct position of the new South’s cotton mill aristocracy and the first labor organization to press for legislation to improve working conditions, for shorter hours, to halt child labor and to demand for safety devices. Unfortunately, they also demonstrated to management that evictions could crush organized labor if it dared protest. Management never forgot the lesson.

In 1895, the AFL under Sam Gompers became interested in the Southern mills. Ironically, the AFL were encouraged by workers in the New England mills who realized if the pay of the Southern mill hand were increased, the Northern mill owners would be less liable to move south. Under the AFL affiliate, the National Union of Textile Workers (NUTW), many strikes, sit-ins and walk-outs occurred. The Southern operative proved much more combative under the leadership of the NUTW than with the Knights of Labor and gained some marginal concessions by the mill owners. However, in 1889-1899 their largest strike in Augusta protesting a wage reduction failed because of, according to McLaurin, lack of finances, absence of adequate leadership, the threat of strikebreakers from rural areas and smaller towns and the lack of support of townspeople as well as their demand for a ten hour day.

In 1901 and 1902, strikes failed in the Carolinas and Virginia and by the fall of 1901 it was painfully obvious even to NUTW leaders that the union had failed in its attempt to organize operatives of the Southern Piedmont mills. Even an attempt to merge the Northern and Southern mill unions collapsed. By 1903, unionism in the textile mills of the South was dead and its rejuvenation lay far in the future. The years of the failure of the mill workers to unionize were the very same years that pellagra began to be reported in the South.

**Pellagra on the Farm**

George Wheeler surveyed Yancey County, North Carolina in 1917. He described the county as the highest portions of the mountainous plateau of North Carolina. The Black mountains compose the southeastern half of the county, while the Smokey Mountains make up its greater portion. Numerous cross chains intersect in all directions leaving very little valley land except along the margins of mountain streams. The county as a whole was sparsely populated when Wheeler studied it with about 13,000 inhabitants over an area of 289 square miles. Aside from Burnsville, the
county seat with a population of about 400 distributed over a relatively large area, there were no towns or villages of importance.

The water supply came from mountains springs while the excreta disposal was largely of the most primitive type. The soil was, with few exceptions, rich, friable and very fertile producing in abundance grains, grasses, vegetables and fruit. Sheep cattle, hogs and poultry were raised. Farming and stock raising were the chief pursuits of the people. In most instances, practically all of the family food supplies were produced at home.

Wheeler wrote that this section of the South and other places of high altitudes were thought to be free of pellagra. Except for one case reported by Lavinder, there was no evidence of the existence of pellagra up to the summer of 1915. However in 1917, the local physicians reported six suspected cases of pellagra to Wheeler and he confirmed five of them. One was a woman who had never eaten meat and rarely milk or butter, her diet being limited to pastries and delicacies. She was treated at the Public Health Service Pellagra Hospital in Spartanburg, induced to drink milk and eat fresh meat and made a satisfactory recovery. Another case was of an eccentric man who lived the life of a recluse and had been committed to the State Hospital for the Insane at Morganton, N.C. One family had three children with pellagra. Both parents appeared ignorant, indigent and shiftless. The household and surroundings were filthy indicating extreme poverty. Their food, largely donated, came from the commissary maintained by the lumber company and consisted of meal flour, fat salt pork, syrup, canned goods and coffee.

“Shiftless” - farm family with pellagra in Yancey County, NC.
Wheeler concluded that cases of pellagra were observed that originated among inhabitants and in the climate of western North Carolina at an altitude of 3,000 feet and higher, that these cases of pellagra followed the same clinical course as those of lower altitudes, and a restricted diet which included little or no milk or meat either because of a dislike for these articles or because they were not available because of extreme poverty, were clearly manifest in each instance.

It would appear that pellagra was not a disease of farmers, at least in western North Carolina, except in bizarre circumstances, unlike the cases of pellagra in the mill workers in mill villages.

The 1920’s

In August of 1918, Goldberger wrote to his wife that “after much thinking and discussion I have decided to wrap pellagra in moth balls until after the war and to find something of more war-time importance to do.” He obtained a transfer to the U.S. Army Medical Corps in September of 1918. Although World War I ended, the pandemic of influenza was reaching its climax. Goldberger was assigned to study the etiology and transmission of influenza. The pellagra experiments at the hospitals in Spartanburg and Milledgeville were discontinued. In shades of his pellagra experiments, Goldberger and his colleagues attempted to produce influenza in U.S. Navy prisoners by spraying their noses with droplets of nasal secretions from influenza patients during the winter of 1919 without success. In 1918, Goldberger wrote a long article directed to nurses that summarized pellagra, his years studying pellagra, its signs and symptoms, its incidence, its relation to poverty, its lack of contagiousness and the importance of a well-balanced diet in its prevention.

The influenza pandemic ended in the spring of 1919, and the restless Goldberger was free to resume his investigation of pellagra. The prosperity brought on by the war resulted in the waning of the incidence of pellagra, so much so that in 1920 the U.S. Public Health Service closed the pellagra hospital in Spartanburg. However, that year ushered in hard times and cases of pellagra exploded. In the middle of 1920, the American economy began to contract and the 1920-1921 depression ensued. The Federal Reserve monetary policy was the main determinant of the end of the
expansion and inflation of World War I and the beginning and subsequent contraction and severe deflation of 1920 by increasing the discount rate from 4 percent to 7 percent. By the middle of 1920, economic activity and employment were rapidly falling and prices had begun their downward spiral in one of the sharpest declines in American History. Milton Freidman opined that the Federal Reserve raised the discount rate due to the necessity of meeting the legal reserve requirement of a safe margin in gold reserves. Whatever the reason, the Federal Reserve System’s first major undertaking in the years immediately following the first World War demonstrated poor policy formulation, and the mill workers paid in unemployment, severe poverty, and the recurrence of pellagra.

In 1920, Goldberger noted the effect of the 1920-1921 depression on the South and resumed his battle against pellagra. He went public. A Public Health Service press release in 1922 from Goldberger was published in the New York Times: “A veritable famine has been developing in the rural districts of the South...and particularly in those of the cotton belt which stretches from Eastern Texas to the Carolinas. The tenant farmers...have been forced by the failure of the cotton crop to adopt a starvation diet that is rapidly decimating them.” President Harding demanded a report from the American Red Cross and the Surgeon General on the South “menaced with famine and plague.” The United Daughters of the Confederacy at first voted to thank President Harding for his concern, but a month later sent him a letter of protest. “Famine does not exist anywhere in the South, and we fail to find a general increase in pellagra.” 5 page 191

Goldberger and his colleagues were delighted with Harding’s support. According to Goldberger, pellagra patients could recover if they received one good meal a day costing but twenty-five cents each. The southern ruling class was definitely not delighted. Goldberger’s advice was, to them, an insulting proposition. Perhaps, the leader in the southern offense was James F. Byrnes, a young congressman from South Carolina who would later become Secretary of State under Harry Truman. Byrnes branded reports of famine and plague in the South as an “utter absurdity.” He declined in advance an offer of emergency aid from the Red Cross. He wrote Harding: “...the average American dislikes having placed in front of his door a flag indicating the presence of a plague...when there exists within his home nothing to justify that characterization.” 5 page 192
Other senators and congressmen leaped to the South’s defense. William C. Wright of South Carolina proclaimed that there was no “grim and gaunt spectre of famine in the Empire State of the South.” Senator Kenneth McKeller of Tennessee denied a famine in his state: “Tennessee was prepared to ship beef, pork, poultry and milk to its poorer northern neighbors should they need it.” The Atlanta Constitution thundered that the reports of semi-famine conditions were “bosh and poppycock.” The denials continued unabated but statistics proved Goldberger correct. The incidence of pellagra and deaths from pellagra in the South increased markedly from 1921 to 1922, but in the end, only Mississippi asked for federal aid. With one-fifth of the state’s population, the Delta had three-fifths of the state’s cases. Goldberger and his associate Dr. Wheeler made essential foods available and then encouraged the people to eat them. At a meeting of The Southern Medical Association in November of 1921, most of those present argued that an infection was the cause of the disease and that Goldberger’s prison farm and other experiments were meaningless. The experiments of Pasteur and the proof that many diseases were caused by infectious agents made physicians of the time “germ enthusiasts,” so their insistence that pellagra was an contagious disease can be understood.

Publicity continued to influence developments. An association of pellagra with poverty was clear, and emphasis on miserable economic conditions in much of the South, where the disease was concentrated was embarrassing, an affront to delicate Southern pride still sensitive from the ‘lost cause’ of half century before. As cases multiplied, embarrassment increased, and attitude toward former heroes changed. Babcock was forced to resign, amid a blaze of publicity and a legislative investigation of the State Hospital for the Insane. He was accused of calling attention to the prevalence of pellagra in the state.4

Pellagra was a social stigma, but its existence was undeniable; thus it was more acceptable for it to be considered infectious than a direct result of poverty. Since pellagra was known to be common in Italy, an influx of Italian immigrant into the South could be blamed for the outbreaks of the disease. No one seemed to notice that the Italians living in the southeastern United States did not have pellagra, since they did not favor the classic diet that led to the disease in that part of the country – cornbread and molasses.4
In August of 1921, Goldberger received exciting news from Dr. W.F. Tanner who was adjusting the diets of inmates of the Georgia State Sanitarium at Milledgeville which housed insane patients, many of whom did not receive an adequate diet either by choice or neglect. Tanner gave a woman pellagrin one half dram of the amino acid tryptophan before each meal. Dr. Tanner knew that amino acids such as tryptophan were the building blocks of protein and that those whose diets were rich in animal protein did not get pellagra. Within five days after receiving the tryptophan, the patient’s dermatitis had completely cleared. He then gave patients with advanced pellagra supplements of milk salts and cod liver oil. Only those who received tryptophan got well. Goldberger rushed to Milledgeville and reported the success of tryptophan to the Surgeon General.

**Labor Management Conditions in Cotton Mills in the 1920’s**

Pellagra remained rampant during the 1920’s. As was noted above, many thousands of deaths were reported yearly with a peak in 1929 of 6,982. In 1930, there were 30,000 pellagrins in Georgia alone. According to the report of the National Center for Health Statistics of the Department of Health and Human Services, the number of deaths from pellagra peaked at about 7,000 in 1928 and 1929.

Loray Mill, 1910
Labor management relations did not improve in the 1920’s. There were many mill strikes culminating with that of the Loray Mill in Gastonia, N.C. John A. Salmon’s book *Gastonia 1929: The Story of the Loray Mill Strike* is the primary source for the following. Readers who are interested in that tragic series of events should read that book. The city of Gastonia is the county seat of Gaston County which lies in the southwestern border of North Carolina that abuts South Carolina. By 1929, it contained more textile plants than any other county in the world. The decade had seen a boom in residential construction, mainly due to the conspicuous consumption of the town’s elite. The mill owners and managers increasingly moved away from the mills and built themselves large, beautiful, lavishly furnished homes in the city’s uptown area.

Dominating the mill-district landscape was the huge Loray Mill, the largest in the whole South. Beyond the mill lay its village, a flock of little white houses all alike, perched each one on brick stilts. The often shocking living conditions in the villages caused health problems that had immense economic and social consequences. Gaston County’s smaller centers – Bessemar City, Belmont, and Mount Holly – presented much the same aspect. They would meet in 1929 as a wave of violent strikes swept through the Piedmont’s textile communities. However, pressure had been building in the mills since the end of World War I. The Great Depression, which for the rest of the country did not begin until much later in the decade, for textiles started with the armistice. Management responded by introducing new technologies. The number of operatives needed to perform particular tasks was greatly reduced. This entailed performing more work without an increase in pay, the “stretch out.” In the North, it was termed the “speed up.” The immediate cause of the strikes, particularly at the Loray Mill was the institution of the stretch out in 1927.

Within fifteen months the Loray Mill labor force was reduced from 3,500 to 2,200 and wages were reduced by 20 percent. Considering that more work had to be done per hour, the result was a wage reduction of between 25 and 50 percent. On March 5, 1928, the entire weave room walked out protesting that they could not live on their wages which had been reduced from $30 to $35 a week to $15 to $18.

During this time the American communist party had decided to form a union to rival the AFL – the National Textile Workers Union (NTWU) - and
planned to stage its first organization drive in the American South, for no other reason than the AFL was about to move in there. The NTWU had done some preliminary organization at the Loray Mill recruiting a few operators. Five union members were fired and a strike was called at the Loray Mill on April 1st.

The story of the strike was marked by violence. Police broke up picket lines mainly made up of women and children, vandalized the small office of the union, arrested and beat up women strikers, hired replacement workers, and finally evicted the mill workers and their families from the mill homes. The workers moved to tent villages put up by the union. There were frequent scuffles between strikers and local men who were sworn in as deputies for the sole purpose of subduing the strikers. The hostilities reached their apex on June 7, 1929 when deputies and other police officers broke up a picket line composed largely of women and children. The deputies and other police officers then went to the tent village. Shots were fired, and the Gastonia police chief, Orville F. Aderholt, was killed.

Sixteen union members were tried for the murder of Aderholt, but were released on bail when a mistrial was declared in September. They forfeited bond and quickly fled to New York. The trouble in Gastonia continued. A large rally of union workers was planned for September 14th. However, the communist leaders of the union realized that there would be trouble at the rally. At the last minute they cancelled the rally and fled to Washington, D.C. Unaware that the rally had been cancelled, a group of union workers set out in a truck to attend. It was stopped by a mob of Loray Mill employees. During the ensuing melee, Ella May Wiggins, an employee of the Loray mill with one child with pellagra was shot and killed. Ella May was a popular speaker known for her ballads in support of working women. Wiggins’ death helped bring attention and sympathy to the plight of the mill workers, but not enough to secure a victory for the union, nor a guilty verdict for whoever killed her. The strike was broken. Employers were successful in keeping unions out of the state a legacy that has continued. As of 2003, only 3.1 percent of North Carolina’s workers are members of unions, the lowest representation in the United States.

Salmond traced the aftermath of the strike. Some of the communist NTWU leaders fled to the Soviet Union. A few of these quickly became
disillusioned with Soviet life and returned to the United States. Some remained in the Soviet Union. Others stayed in the United States to either continue in the communist cause, rail against it or disappear. The workers tried with varied success to find employment in the Loray or other mills. Management of the mill prospered and some who were active in the strike and the subsequent trials developed political careers. The mill itself prospered under various owners until the early 1990’s when it closed. It now stands empty and is being promoted as a possible shopping center, office space and apartments.

Final Studies and the Answer

There is no record that Goldberger or any of his team were involved in the labor/management struggles in the 1920’s. In fact, Goldberger turned to the laboratory and worked to find an animal model of pellagra. By August of 1921, when Goldberger entered the Hygienic Laboratory in Washington he found that it had changed from 1914. The small Hygienic Laboratory that Goldwater knew had become a modern institution with a large scientific staff. Goldberger learned that investigators at Yale University might have produced pellagra in dogs. He fed dogs in his laboratory a “pellagra” diet and they developed a disease of dogs known as “black tongue” before succumbing to vomiting and diarrhea. Goldberger remembered that the incidence of black tongue in dogs was most frequent in the same parts of the country as pellagra.

Goldberger and colleagues then added one ingredient at a time to the pellagra diet of dogs. They added brewer’s yeast only to stimulate the appetite of the dogs. To their surprise, brewer’s yeast banished black tongue very quickly. The yeast was the only tested substance that yielded such marked results. The Public Health investigators realized that yeast contained the pellagra preventive factor (PPF) and then found brewer’s yeast to be the most potent source of this factor. Would what healed dogs cure the pellagrous patients under Tanner’s care at Milledgeville? Previous investigators had found that yeast had at least two vitamin B factors, a heat labile factor and a heat stable factor. Goldberger, Waring and Tanner had postulated the existence of a previously unrecognized dietary factor concerned in the prevention of pellagra (tentatively designated as the “P-P factor” or “pellagra preventative vitamin”), and this
was now held to be identical with the heat stable factor of vitamin B. Rats whose rations lacked this heat-stable factor were described by Goldberger, Wheeler, Lillie and Rogers as developing a pellagra-like condition about nine weeks after this dietary deprivation.

Goldberger and Tanner began their human trial of yeast on May 26, 1923. At first, only two patients were given brewer’s yeast. Their dramatic recovery encouraged Goldberger to expand the trial to twenty-six patients the following year. Every day patients were served dried brewer’s yeast at supper, usually drenched in syrup to make it palatable. In several days, the pellagra was in retreat.

Goldberger did not know why brewer’s yeast cured and prevented pellagra, but it did so because it contained the later isolated niacin. And brewer’s yeast was cheap. Southerners could now face the spring of 1925 without fear. Even the poorest of them could afford brewer’s yeast and Goldberger’s results were soon broadly disseminated. Goldberger had stumbled into a complex biochemical relationship that would explain why tryptophan and niacin benefited pellagrins. The amino acid tryptophan and the vitamin niacin are related. Tryptophan, not produced in the human body, is a precursor of niacin in the pathway to niacin, hence its beneficial effect on pellagra.

Goldberger’s last triumph occurred in 1927. Again flood waters submerged the Mississippi delta. In the spring of 1927 the seasonal rains were unusually heavy. Tributaries of the Mississippi overflowed their banks. Meanwhile, the Mississippi itself was rising higher than it had before. By April, the river was carrying in excess of three million cubic feet of water each second. By the time the waters finally subsided, 16,570, 627 acres had been flooded in 120 counties covering seven states. Over 160,000 homes were flooded, and over 41,000 structures totally destroyed. Of course, Goldberger headed south. Considering past floods Goldberger and his colleagues estimated that the number of pellagra deaths in four states would be 2,300 to 2,500, unless drastic measures were taken. Fortunately, they were. Food and yeast were provided by the American Red Cross, and the number of pellagra cases and deaths was much less than expected. Still, pellagra did not recede with the flood waters. Twelve hundred cases of pellagra were reported in just two counties in Mississippi between 1927
and 1929. The later Goldwater became convinced that the real cure to pellagra lay not in medicine, but in economics.\textsuperscript{5 page 186}

At the end of the 1920’s the rate of pellagra in the South increased dramatically. The deaths from pellagra increased from 3,000 in 1925 to 6,900 in 1929.\textsuperscript{20p41} The Public Health Service put the case rate at more than 200,000 during the years 1927 through 1930.\textsuperscript{5 page 193} While pellagra may have been more prevalent in the rural areas, it was much more conspicuous in the mill villages. In 1930, \textit{The American Federalist} reported the average man working in the mills full time earned only $12.77 a week of which $11.44 should go for food if a family of five were to be fed adequately. With rent to pay and clothing to buy, obviously it was impossible to spend so much at the grocery. In 1930, there were 20,000 cases of pellagra in North Carolina’s industrial population. Only the coming of the New Deal with the inauguration of President Franklin D. Roosevelt and the food relief program brought food to the South’s hungry. The creation of new jobs in agencies like the Civilian Conservation Corps helped. The Tennessee Valley Authority and the Rural Electrification Association hastened the spread of refrigeration which helped to make food available at low cost.\textsuperscript{5 pages 200-206} However, the final conquest of pellagra did not come until the prosperity World War II and the discovery of Dr. Conrad Elvehjem. Goldberger, who died in January of 1929, saw none of this.

Virgil P. Sydenstricker traced the biochemical progress of pellagra and its treatment from Goldberger’s discovery of brewer’s yeast in 1921 to 1958.\textsuperscript{2} Virgil Sydenstricker (1889-1964) was from the same family, but not closely related to Edgar Sydenstricker, the colleague of Goldberger. Virgil Sydenstricker had a remarkable career. In the field of hematology, with G.H. Wipple, he enabled blood to be stored and “banked.” In the 1930’s, he began research in nutrition addressing problems of vitamin deficiency diseases and malnutrition. He reported experiments in rats in nine articles covering nutritional factors that influenced the eye and a similar number of articles on amino acid deficiencies with special attention to threonine. He published nine articles on niacin and pellagra, six articles on riboflavin deficiency and five on war-time nutrition. During World War II he developed nutritionally sound combat rations for the U.S. Army and was in charge of the medical and nutritional care of 60,000 prisoners released from German prison camps.\textsuperscript{50}
Virgil Sydenstricker wrote in 1958:\(^2\)

“By 1924, pellagra had maintained its steady increase throughout the South. Thanks to Goldberger’s propaganda and the influence of Italian pellagralogists, dietary treatment had been almost universally adopted in hospitals so that mortality rates were lower but total deaths were not materially affected. Prevention by diet was never practical due to economic conditions as well as stubborn food habits. Further investigation of yeast showed that the factor curative and preventive of black tongue and pellagra resisted degrees of moist heat that entirely destroyed the beriberi preventive factor. It was also found that the substance, now called ‘pellagra preventive factor’ by Goldberger could be adsorbed on fuller’s earth and eluted therefrom and that the eluates were active in the cure and prevention of the disease.”

Picking up on the work of Goldberger, Conrad Elvehjem of the University of Wisconsin, found that nicotinic acid cured black tongue in dogs, an analogous disease to pellagra. Elvehjem and his colleague Carl J. Koehn had found that a filtrate factor from liver extract could cure diet-induced pellagra in chicks. That filtrate extract was designated as the vitamin G fraction after Goldberger. To confirm their findings in dogs, they induced black tongue in these animals with a diet of yellow corn, before supplementing the diet with the vitamin G fraction. Elvehjem and his colleagues were later able to isolate and identify nicotinamide and nicotinic acid from vitamin G as the curative factor for black tongue in dogs.\(^9,\)\(^10\) Later, Tom Spies and associates established that niacin also cured pellagra in humans.\(^51\)

Many experiments by many investigators were performed over the next years, but in summary evidence emerged that black tongue and pellagra might be a manifestation of more than one dietary factor. In the meanwhile, the disease increased despite yeast being furnished free by the Red Cross and government agencies due to poor food habits, economic stress, and the enormous backlog of chronic malnutrition. In 1940, there were still more than 2,000 reported deaths, in spite of all the efforts educational and therapeutic put forth by federal and state organizations, the Red Cross and local welfare.

The Second World War was responsible for the conquest of pellagra in the United States. The great increase in employment, and the
mobilization of the armed forces provided almost everyone with an income either from a job or a soldier’s pay. The enrichment of flour put a reasonable quantity of B-vitamins into the diet. Rationing inspired even the most backward souls to buy and eat the good high-protein foods to which they had never before aspired. Since 1945, pellagra has been a clinical curiosity seen only in the occasional food faddist, senile recluse, or chronic alcoholic.

Though pellagra ceased to be a clinical problem, the biochemical puzzle of the exact relationship of diet to the disease remained unsolved. It had been observed many times that there was no direct relationship between the nicotinic acid (niacin, vitamin B-3) content of diets and the efficacy in producing black tongue or pellagra. This suggested that there might be some other substance which could substitute for or be a precursor of nicotinic acid. It was then found that niacin can be synthesized from tryptophan and that both riboflavin (vitamin B-2) and pyridoxine (vitamin B-6) are required for the metabolism of tryptophan and that pyridoxine is essential for the synthesis of niacin from the amino acid. It was also shown that corn causes a marked increase in nicotinic acid requirement. These findings clarified why pellagra is prevalent in a maize eating population. A diet low in good protein and containing large amounts of corn actually increases the requirement for nicotinic acid and, at the same time, blocks its endogenous production. If there is a deficiency of riboflavin and pyridoxine as well, the utilization of what little tryptophan that may be available is impossible and the diet is rendered virtually niacin free.

**Pellagra in the United States Today**

Although the epidemic of pellagra has disappeared in the United States, it still may be seen rarely today. Stratigos and Katsambas wrote of the mechanism for the various diseases that mimic pellagra.

“Deficient food: This group includes patients who for various reasons do not receive ample quantities of food, especially animal protein (chronic alcoholics, psychiatric patients, monks, aged widowers living under poor standards, starvation) and patients fed solely on corn or *Sorgham vulgare* (jowar -India), who constitute the ‘endemic’ type of the disease.
“Malabsorption: When malabsorption is present, the oral administration of animal proteins, tryptophan and nicotinic acid is useless. Thus cases of pellagra have been reported associated with jejuno-ileitis, gastroenterostomy, and Crohn’s disease. The disease has also appeared in patients who had been subjected to total or subtotal gastrectomy.

“Chronic alcoholism: Pellagra in chronic alcoholics represents a combination of the two previous categories. Their diet is very limited in animal proteins, nicotinic acid and vitamins. Also the absorption of the already poor diet, as well as its use by the hepatic cells, are very incomplete. Thus it is sometimes observed that the oral administration of vitamins and of proteins fails to protect them, and the parenteral administration is indispensable.

“Abnormalities of tryptophan metabolism: Tryptophan, which is an essential amino acid, is obtained entirely from food. Part is utilized in protein synthesis and the remaining is involved in various biologic functions...Any metabolic disturbance of tryptophan which leads to a decrease in nicotinic acid production would result in the clinical manifestations of pellagra. In Hartnup disease there is a block in the tryptophan-peroxidase pathway resulting in skin changes analogous to those of pellagra. Carcinoid neoplasms produce excessive amount of serotonin. In healthy people, only one percent of dietary tryptophan is converted to serotonin; however, in patients with carcinoid this value may increase to 70 percent. The diversion of tryptophan to making serotonin in patients with metastatic carcinoid results in tryptophan deficiency. Carcinoid syndrome thus may produce decreased protein synthesis, niacin deficiency and the clinical manifestation of pellagra.

“Chemotherapeutic agents that are known to produce pellagra are isoniazid, 6-mercaptopurine, 5-fluorouracil, azothioprine. anticonvulsants and chloroamphenicol.

Comment

The European peasantry remained on their land. The American share-cropper of the South did not. These were pushed from their small plots by the cultivation of King Cotton and pulled by the promise of a better existence in the mines and mills of post-construction South. The South had
provided them with small farms that supported their food gardens, poultry and pigs and as well as meat from hunting. But in the mill towns, their poverty and squalor led to a diet of non-nutritive corn, fat back and molasses that produced pellagra, tuberculosis, infant mortality as well as other diseases. Between 1904 and 1940 about three million people in the United States, almost entirely in the South, developed pellagra with 100,000 fatalities. The fate of the Southern country-poor reminds one of the English peasant who was driven from their farms by landlords eager for sheep pasture and ended in the mills and factories of the British cities.

The reaction to poverty and pellagra was similar in Europe and the American South as far as the establishment was concerned. In Europe, the accepted theory that pellagra was due to “bad corn” and not socio-economic catastrophe removed any responsibility that the affluent might have for the disease. In the United States South, the affluent escaped blame in two ways. They denied that pellagra occurred at all and, if so, it was not due to poverty and squalor, but was an infectious disease that could strike anyone. When the establishment had to admit that underlying cause of pellagra, they were still helpless. The South was extremely poor.

At the turn of the 20th century, the South did not have the affluence to afford the wages and give the living standard that would help the mill worker and miner to live adequately. As a Southern health official pointed out, even if the dietary theory were correct, the South did not have the resources to assure an adequate diet for all its inhabitants.

The Southern mill owners were trapped in the same vicious competition that led to cotton mills translocating from New England to the South and, later, from the South to overseas. Although the discovery of niacin and niacin-fortified bread made the incidence of pellagra decrease, it was only the rise of living standards during and after World War II that pellagra disappeared. The Great Depression of the 1930’s caused a repeat of the poverty of post-construction South, but the intervention of the Federal Government and the New Deal softened the blow.

Goldberger and his associates from the United States Public Health Service, in the face of vicious criticism, proved that pellagra was a socio-economic disease precipitated by an inadequate diet. Goldberger came so close to isolating niacin that Elvehjem, the man who did, initially called
niacin vitamin G in honor of Goldberger. Goldberger was nominated for the Nobel Prize many times, but never won.

The Americans with all their infighting, denials and detours discovered the cause, found the cure and eliminated pellagra in 30 years, something that their colleagues in Europe had been unable to do in three centuries.

Postscript

The New York Times Magazine of May 6, 2012, page 24 published an article by Pietra Rivoli titled: “Anybody Want a $1 Million Pillowcase Machine?” She tells of a Mr. Mike Diamond who operates the Republic Textile Equipment Company in York, South Carolina. For fifty years he has sold used textile machinery that he purchases from textile mills that have gone broke.

“The going-broke business in the textile industry is clustered around the 1-85 corridor, from Gastonia, N.C. to Greenville, S.C. Diamond joined his father in the going-broke business more than a half century ago. In its early years, Republic was based in New York, in proximity to the Northern textile factories that were closing...Republic moved to South Carolina to follow the movement of the textile industry from New England to the Piedmont region [where the textile factories there were going-broke]...For about 50 years, Diamond has supplied used textile machinery to more than 40 countries and played a central part in the gradual movement of textile production from rich countries to poorer ones...Even within a single country textile production gradually shifts to poorer regions – just as it has in the United States – usually in search of lower labor costs.”
References


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