Let’s clear the air of that nocturnal miasma. Cigar anyone?

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Ever since they could remember, Thaddeus and Alexandra enjoyed listening to their father’s accountings of mysterious illnesses — assembled stories that were meant to be enlightening and entertaining. Some were told them by their father, others by their grandfather; still others had been acquired from friends and acquaintances located throughout the world. And then there was their extensive reading of the medical literature. Now that Thaddeus was a junior in medical school and Alexandra hoped to soon follow in the family tradition, these stories took on an even greater fascination — each hoped to become a medical detective in real life. Home for the holidays on this cold winter’s evening, December 21, 1990. Thaddeus and Alexandra had earlier seen their younger sisters to bed. They now sat on the couch with their mother Elizabeth, a former nurse, who eagerly awaited tonight’s puzzle ready to add her own perspective to the health care dilemma that would unfold. As was so often the case when he told these stories, Theodore Conrad was nestled in a well worn armchair, his trusty pipe emitting a smokey tendril and distinctive fragrance in keeping with his long-time favorite cavendish tobacco. And then there were story titles laced with his own brand of humor. Tonight’s story, he suggested, with a twinkle in his eye, would be titled “Let’s Clear the Air of That Nocturnal Miasma. Cigar Anyone?”.


August, 1793. Philadelphia, the Colonies’ capital, was in the midst of an epidemic similar to those of 1699, 1741, 1747 and 1762. This time, one tenth of the city’s population would die of the mysterious illness. Death was often preceded by black vomitus, considered a most deadly contagion. What caused this illness and from where did it arise? After a 30-year hiatus when had it arrived and by what means? Was it imported by vessel from ports in the West Indies? Why had it appeared so suddenly, so mysteriously, and killing so mercilessly?

The origins of the scourge were obscure — contagion was considered most probable. Some thought it emanated from a nocturnal miasma that appeared in low marshy places borne by a swamp breeze, like the moist sultriness of a tropical jungle. Perhaps it came from morbid exhalations of organic decomposition found in gutters and wharves, like the putrid smell found along Water and Front Streets. The mayor ordered a purification of the atmosphere and cleansing of the city. Bonfires dotted street-corners to eradicate fomites belonging to the ill; cannons were sounded periodically to clear the air. Warding off evil humors, women and men alike smoked cigars to the point of intoxication; they chewed garlic and carried vinegar or camphor-soaked sponges at their mouths when leaving their homes; tarred rope was worn at the neck or waist as a talisman.

Dr. Benjamin Rush, one of 5 physicians to affix their signature to the Declaration of Independence, would chronicle the city’s epidemic. A majority of patients had fever, some to profound levels. In response to the miasmata, Rush divided cases into 3 categories: severe, accompanied by coma, languor, a weak, slow pulse, and a disposition to syncope; moderate, with headache, delirium, vomiting, thirst, and quick pulse; and mild, often found in suburbs. In vivid and compassionate terms, Rush wrote of the devastation that affected entire families, rich and poor alike, and frenzied masses that crowded Philadelphia streets fleeing the city in every direction. This deadly malady had and would continue to ensnare other ports along the eastern seaboard, including New York, New Haven, Boston and Baltimore. The illness disappeared with October’s rain and frost; peace and tranquility were restored.

Elsewhere in the Americas this illness would also claim many lives. In 1794, one half of the 12,000 man English army that occupied the West Indies would succumb. In 1798, 90% of the 24,000 member French army in Santo Domingo was lost. Spanish soldiers, who managed to survive the illness in the Caribbean, brought it home. Deadly epidemics followed in Barcelona and Seville. In the 19th century, ports along the Mississippi Valley and
Gulf Coast, including Memphis, New Orleans and Mobile, were struck. Trains passed through these sites at full speed and with windows tightly closed.

**January, 1898.** The Spanish-American War would turn the attention of the Americas to Cuba, the pearl of the Antilles and Havana in particular, where a U.S. battleship, the *Maine*, had been sunk by an underwater mine fastened to its hull by an unknown assailant. Newspapers, such as the *World* and *Journal*, were one of the few sources of public information in the States and competition between them was fierce. They used their influence to flame public opinion against Spain by drawing on accounts of the War that extended beyond the boundaries of truth-in-reporting. Each searched for an advantage; each introduced colored comics. One such comic titled “The Yellow Kid”, featured a young boy whose yellow-colored features smeared easily and led to the term ‘yellow press’. The phrase ‘yellow journalism’ came about to describe their tainted accounting of the war. Epidemics that broke out amongst Spanish and American armies were considered less newsworthy and yet it was these epidemics that proved more ferocious and destructive than either army. Curiously, Cubans were unscathed by the mysterious illness. It was only soldiers, visitors, or immigrants, who were afflicted.

Even 100 years after the epidemic in Philadelphia environmental cleansing remained a primary tenant of prevention. It was on this premise that Willie, as he was affectionately known, would set out to cleanse Havana and rid it of this pestilence. Appointed Chief Sanitation Officer of the U.S. Army stationed in Havana, he vowed to break the grip this illness held on Havana for 150 years. He was consumed by the righteousness of his efforts to cleanse every household, street and alleyway and ill prepared when a local physician, Carlos Findlay, advised that the illness had little to do with filth. Findlay proclaimed the importance of *Stegomyia*. He could show that wherever *Stegomyia* was found, there were outbreaks of the disease. This included certain latitudes and temperate seacoasts and waterways, never mountain tops. Despite numerous attempts, however, Findlay had never been able to directly demonstrate a critical component of his theory — acquisition of the disease by man exposed to *Stegomyia*. Willie and Findlay became friends and joined forces to solve the mystery.

In the summer of 1898, several pieces of the puzzle came to light from, of all places, Orwood, Mississippi, where Dr. Henry Carter of the Marine Hospital Service recorded, firsthand, events involving a small epidemic in this rural community. Carter’s surveillance of the disease involved patients living in farmhouses isolated from one another by miles. This afforded him the opportunity to monitor each house separately. He found that if visitors to the sick arrived within 10–14 days of the onset of the illness, they were not affected. Those arriving after day 14, had a greater likelihood of taking ill. Even after a patient had died and all his/her clothing and bedding had been destroyed, visitors could still become ill. It was now evident that with *Stegomyia*, unlike influenza or measles, the patient created a disease-bearing environment. Moreover, the 14 day gap suggested a third component was involved referred to as an ‘extrinsic incubation’. Carter would subsequently be appointed Havana’s quarantine officer.

The continued seriousness of the illness in Cuba prompted President William McKinley and Surgeon General George Sternberg to dispatch a board of army medical officers there in 1900. This commission would also come to include Willie and Findlay; Carter served as consultant and recounted his Orwood findings. The *Stegomyia* theory began to gain credence.

The commission began its own clinical studies. Several volunteers, including two commission members and a nurse, were exposed to *Stegomyia* that had been collected in the field; a commission member and the nurse became seriously ill and died 2 weeks later. This unfortunate case study did add immeasurably for it demonstrated a critical period to acquiring the disease. Other volunteers were sought from amongst American soldiers and Spanish immigrants with various inducements. A veritable clinical research unit was built — a specially constructed room divided in half by screen partition; on one side *Stegomyia*, absent on the other. Only volunteers on the side with *Stegomyia* became ill. After removing *Stegomyia* new volunteers did not become ill. Fomites were addressed by having volunteers wear garments laden with *vomito negro* for 20 days. Nada! Finally, blood obtained from the sick on day 3 of their illness was injected intravenously into healthy soldiers, who then became ill. An inoculum of filtered blood also caused the illness while this blood borne factor could not withstand heat — an innocent inoculum. The *modus operandi* of the mysterious illness that had claimed so many lives over the course of 200 years was now evident.

Theodore Conrad interrupted his story telling to pose several questions to Thaddeus and Alexandra. What is *Stegomyia*? What is the illness? Who was Willie? How would you predict he could eradicate this mysterious disease from Havana?

**ANSWER:**

Thaddeus leaped at the opportunity, certain his responses would be on track. *Stegomyia fasciata* (*Aedes aegypti*) is a strain of mosquito whose bite transmits the virus that causes yellow fever. Willie was the nickname of William Crawford Gorgas, who would eradicate yellow fever from Havana. Gorgas’ systematic elimination of the insect was based on (a) understanding the insect’s behavior (the basic sciences); (b) clinical features of the illness (the clinical sciences); and (c) his concern for public health (the population-based sciences). First, enhanced surveillance and more immediate reporting of all new cases to enforce early isolation. The first 3 days after acquiring the disease
had proven the critical infectious period during which an uninfected mosquito could acquire the illness from an infected patient. This had been the lesson learned from the death of commission member, Dr. Jesse Lazear. Fumigating the home of a new case and surrounding houses followed. The culprit, a female Stegomyia, rarely strayed beyond these boundaries; she was dependent on a blood meal to induce a laying of her eggs. Second, the mosquito’s larval stage required water, specifically fresh water found in containers located within and outside the home. This included cisterns used to collect rain water, flower pots, and glass cups of water into which were submerged table legs and bed posts to impede ants. This approach afforded Gorgas and his staff the opportunity to target the elimination of the insect from its favored locations. Covers were placed over cisterns; only a small aperture, covered by wire netting, permitted the entrance of rain water. Next, it was recognized that larvae surfaced from water to breath. Kerosene was therefore thinly layered on water supplies to eliminate this contact with the atmosphere. Within 6 months the disease was under control. In May, 1901, Gorgas wrote his colleague Walter Reed, then stationed in Washington, of his success. Reed, a member of the commission sent to Havana, had conducted pivotal clinical studies in Havana that linked the female Stegomyia, with its rigid proboscis, to the transmission of the disease.

Not to be outdone, Alexandra jumped in with her own anecdote, one she knew well after preparing for a special project in school. Over the next decade, Gorgas would use this experience to eradicate yellow fever from the Isthmus during construction of the canal that would join the Atlantic and Pacific Oceans. He was appointed Surgeon General of the Army in 1914, a position of distinction, as opposed to today where political intrigue clouds at the office. Elizabeth completed the story with her assertion that Gorgas, although a general, saved a great many lives and prevented further dissemination of this dreadful illness to other parts of the world. His army left behind neither death nor destruction.

Postscript: Continued surveillance and environmental sanitation, in the Gorgas tradition, will determine whether yellow fever remains under control in the Americas. Aedes aegypti has returned to the southern U.S. and its cousin, Aedes albopictus, an oriental import, has made its appearance along the Mississippi and Missouri river valleys over the past decade.

It is now recognized that the weak, slow pulse and disposition to syncope despite high fever, a relative bradycardia (Faget’s sign), is due to inflammation of the heart’s conduction system — the viral myocarditis of yellow fever.