

Antonio Luna, science and the emerging Filipino national identity

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ABSTRACT

In this essay, I review General Antonio Luna's science career as the first Filipino doctoral student in science sent by the colonial government on a scholarship. I review the significance of Luna's work on malaria in the context of an emerging international research program. I discuss this public health research program within the context of the changing economic policy of Spanish Philippines after the 1762 British Invasion which resulted in the entry of technological innovations which prompted social change. These changes gave rise to a Filipino national identity which culminated in the Philippine Revolution of 1896. I also discuss the continuity of this colonial science research policy especially in health through the period of American sovereignty and the science and research policy of the Philippines in the 21st century.

Keywords: Antonio Luna; history of science; science policy; malaria, Filipino nationalism

INTRODUCTION

The life of General Antonio Luna cannot be studied outside the contexts of European colonialism and American imperialism and the response of his people to these, the formation of a national identity, ardent defense of it and their sovereignty.

Filipinos remember Antonio Luna as a hotheaded but brilliant general with a methodological approach to tactics. He was a strict disciplinarian of his troops admired and loathed by friends and foes and earned the respect of his American nemesis. This aspect of his life is well documented in history and even in film, but his earlier career as a scientist is not with historical accounts unclear on the nature of his scientific research.

That being said, it cannot be doubted that Luna's training as a scientist is within the context of identifying as Filipino, an identity separate from that of the metropolitan power. While initially Filipinos sought assimilation to the Spanish metropolis that eventually proved untenable. The only choice was secession. And at that time, inspired by the ideas of the Enlightenment and its revolutions—the French and American, the Filipinos chose revolution. Thus this is the story of the Generation of 1872, the first generation of people in the Philippines to identify themselves as Filipinos regardless of their racial or cultural origin.

The Philippines together with Cuba, Puerto Rico, and the minor outlying islands of the Marianas were all what remained of Spain's empire in 1872. The Spanish had recognized the independence of the American republics especially that of Mexico 40 years beforehand. The Philippines, Spain's last remaining colony in the Pacific, was not insulated from the revolutionary movements that inspired the French people and the American colonies of the preceding century. The wars of independence of the Americas also filtered to the emerging national consciousness of the Filipino.

Where does science lie in this national identity narrative? One of the key ideas of the Enlightenment is that science transcends national and religious boundaries. This is how we view science today. While the Arab world tries to recover the history of its Golden Age of Wisdom, Arab Muslim scientists emphatically declare that there is no such thing as Islamic or Arab science today, but only science (Al-Khalili, 2011). But in stating so, they do

not mean that by doing science they lose their Arab identity or even their Islamic religious tradition. Medievalists who study science say in agreement, that there is no such thing as Roman Catholic science, only science.

The history of science in the Philippines is something unstudied with only a few scholars like Professor Olivia Caoili of the Political Science Department, University of the Philippines Diliman delving into this topic (Caoili, 1986). The political and social context of science in the Philippines is well known in relation with the history of education (Caoili, 1983). However, there is little known about the work and motivation of scientists during the Spanish and American colonial periods. We only know their names. But to shed light on these, we have to know the science policy environment of the colonial period. Here is where a study of Antonio Luna becomes of interest.

FROM INDIO TO FILIPINO

Throughout the Spanish colonial period, the Spanish had a classification of the inhabitants of the archipelago. The natives were called "Indio", the Spanish born in the Philippines were called "Filipino", and the Spanish born in the Peninsula were "*peninsulares*". The Indio had a history of contact with Asia prior to Spanish conquest in 1565. There were thalassocratic states with trading relations with Asia's kingdoms and the Arabs, which introduced Islam in 1380. Evidence of which is in written records, archaeological evidence of trade and the accounts of the Spanish friars themselves who noted that the natives were literate in their own *baybayin* script (Erdrich, 2008). While it is possible that the first Europeans to encounter the archipelago were the Portuguese, the first historical record of a European is that of Ferdinand Magellan who sought alliances with the thalassocrats of the central islands which eventually resulted in his death in 1521, under the command of Lapu-lapu during the Battle of Mactan, in Cebu, an incident so much part of the mythos of the Filipino nation today.

Trade was Spain's objective for colonization of the Pacific and with it the conversion of the natives to Catholicism. Spain wanted to have a foot in the China and spice trades which was then a Portuguese monopoly. After Magellan's expedition, several expeditions set sail across the Pacific, from the newly conquered Mexico. It was the Ruy Lopez de Villalobos expedition in 1544 that named the archipelago after Philip II of Spain, *Filipinas*, as the

islands are still known to this day. Miguel Lopez de Legazpi's expedition in 1564 was the most successful—resulting in the discovery of the *tornaviaje* which allowed the galleons to return from Asia to Mexico (Armendariz, 2011). This made possible the galleon trade which started at the instance of Spanish conquest of the rajahnates and thassocratic kingdoms of Cebu and Manila (1571), thereby establishing the Spanish rule. The galleon trade ended with the Mexican War of Independence in 1812.

During the intervening period of 1565 to 1812, Spanish rule initially followed the governance of their American colonies as *reducciones*. Indios were settled into towns in encomiendas. The Spanish friars under the *patronato real* administered the parishes and acted as civil agents of the King. The encomienda system was abolished through a royal decree and a civil administration consisting of towns and provinces were established. The British invaded and occupied Manila in 1762 which showed the Indio that their colonizers were not invincible. Several revolts marked resistance to Spanish rule, mostly rooted on economic grievances but all of them were crushed. With the gradual opening of the Philippines to trade with the European powers and later with the newly independent United States (1809), liberal ideas from the continent entered the colony. The colony was formally opened to world trade in 1834. A growing and prosperous *peninsulare* and mestizo classes gradually identified themselves as citizens of *Filipinas* and demanded equal representation in the Cortes. With Spain's short lived experiments with liberalism in 1812 (Cadiz Constitution) this representation was granted but eventually taken away when the Bourbon monarchy was restored. A growing merchant Indio (*principalia*) class was also becoming prosperous and towards the middle of the 19th century, had significant stake in the trade of agricultural cash crops like sugar, coffee and tobacco (Legarda, 1957). Trade in these crops made the *principalia* in regional cities like Iloilo, Bacolod, Malolos, Cebu, and Lipa very wealthy.

The wealthy Indio classes were able to send their children to the University of Santo Tomas (UST)—the only university in the colony—and to Spain to take degrees in Law and Medicine. The Indio who had children in the clergy eventually sent their sons to take higher theological studies.

The Suez Canal was opened in 1869, making the effort less expensive and much easier. Their compatriots in the colony called these foreign educated Filipino students as "*ilustrados*" which means "the enlightened ones". But the elite tradition of sending Filipino students to Europe did not start in the

1850s. Filipinos from the wealthy classes were sending their children to Europe even before, right after the British Invasion which radically changed the economic dynamics of the colony (Legarda, 1999), forcing the Spanish to open the islands to foreign trade (De la Costa, 1967).

THE STAGE OF 1872

Some historians say 1872 is the year when the Indio became Filipino, a people with a national identity (Francia, 2010). What happened in 1872?

The discontent in the Philippines started from the native clergy who never had the chance to be appointed pastors of their parishes. The parishes were occupied by the Spanish friars, and while the Indio could be ordained, he cannot aspire to being more than a coadjutor. While the Tridentine reforms mandated the care of parishes to the diocesan clergy (Schroeder, 1955), this was honored in the breach by the friars on grounds of race. The leading mestizo priest of the time and canon of the Manila Cathedral, Pedro Pelaez demanded reform but he died in his cathedral when it collapsed during an earthquake in 1863. His student, the Indio doctor of theology, Jose Burgos continued the struggle together with Mariano Gomez and Jacinto Zamora. They would be implicated in the Cavite Mutiny of 1872 and were executed (Francia, 2010).

ENTER ANTONIO LUNA; REFORM AND PROPAGANDA

Antonio Luna belonged to the prosperous Indio merchant class which was sent to the best schools of the colony and eventually to Europe. Luna's career cannot be understood outside the context of the demands for reforms by the *ilustrado* expatriates in Europe.

Luna was born on 29 October 1866 in the Binondo commercial district of Manila as the youngest among seven children of Joaquin Luna and Laureana Novicio. The Luna family was from the upper merchant class who made its fortune from the Spanish tobacco monopoly thus their business in Binondo. At the middle of the 19th century, the merchant class of Filipinos achieved prominence in the production and distribution of agricultural commodities as the colonial economy opened to foreign trade (Legarda, 1957).

The family was from the Ilocos region in northern Luzon. With the family's relative and increasing affluence, the Lunas were able to send their children to the Jesuit run Ateneo de Manila for the bachelor's degree and to UST for professional education. In Europe, Luna was an active participant in the Propaganda, a reform movement of Filipino expatriates in Madrid which was organized in a cohesive group sometime in 1886 (Schumacher, 1989). The Propaganda sought the following goals: 1) Filipino representation in the Spanish Cortes; 2) secularization of the Roman Catholic clergy in the Philippines; 3) constitutional equality for Filipinos; 4) creation of a secular public education system; 5) abolition of mandatory labor service; and 6) civil rights for Filipinos (Schumacher, 1973).

The Luna brothers—being known for their role in the Propaganda in Spain—were implicated in the Katipunan uprising and arrested in Manila. Prior to his arrest, Antonio Luna had been the Municipal Chemist of the City of Manila, having passed the qualifying exam upon his return from doctoral studies in Europe in 1894 (Jose, 1999).

PHILIPPINE REVOLUTION

Luna at first did not join the revolution but his legal deposition denying his participation implicated the Katipunan revolutionists. Nevertheless, Luna was exiled and jailed in Spain in 1897. His brother Juan, appealed to the Queen Regent Christina of Spain and Luna was released. The second phase of the Philippine Revolution began in 1897, when the Katipunan revolutionist from Kawit, Cavite, Emilio Aguinaldo consolidated his leadership of the Philippine Revolution in the Tejeros convention that elected him as President of the Revolutionary Government (Jose, 1999).

Having learned of this development and newly released from prison in Spain, Luna then began studies of military tactics, trench fortifications, and military command under the Belgian General Gerard Leman in Ghent. In 1897, he returned to the Philippines by the way of Hong Kong, where Aguinaldo and his revolutionary government as a result of the Pact of *Biak-na-Bato* offers amnesty, prompting him to voluntarily go into exile. In Hong Kong, Luna received his military commission from Aguinaldo. By July 1898, Luna was in the Philippines ready to assume command of the Filipino Army. In the Philippines Luna was appointed as a delegate to the Malolos Congress

that ratified the constitution of the Filipino Republic. He was also dean of the Faculty of Pharmacy of the short-lived *Universidad Literaria de Filipinas*, the Filipino Republic's institute of higher learning (Jose, 1999).

FILIPINO WAR OF NATIONAL LIBERATION

The sinking of the USS Maine in Havana Harbor on 15 February 1898, provided the *casus belli* for United States intervention in the Cuban War of Independence. This resulted in the Spanish-American War where the US Navy destroyed the Spanish fleet in Manila Bay on 1 May 1898. Under the presumption that American interests will favor Philippine independence, Aguinaldo returned to the Philippines to set up his government. Independence of the Philippines was proclaimed on 12 June 1898 in Kawit, Cavite. With the Treaty of Paris ending the Spanish-American War, Spain ceded Cuba, Puerto Rico, the Marianas and the Philippines to the United States on 12 August 1898. American troops occupied Manila on the next day but without a mock battle to save Spanish *amor propio*. Filipino troops surrounded Manila in an uneasy confrontation with the American army. The lines held until the outbreak of the Philippine-American War on 4 February 1899. On this day Luna received orders from Aguinaldo to defend the northern approaches to Manila. While Luna was able to slow American advances, the superior arms of the American army resulted in the collapse of the Filipino defence and the army's retreat northward towards Tarlac province, 150 kilometers north of Manila. Aguinaldo's cabinet was divided between acceptance of offers of American autonomy and sovereignty. Luna bitterly opposed any offer of American autonomy. Luna was known for his temper and harsh discipline for his troops. This and the factionalism among the government and the army led to Luna's assassination on 9 June 1899 in Cabanatuan (Jose, 1999).

LUNA AS A SCIENTIST IN A REVOLUTION

Antonio Luna's career as a soldier is well documented and several biographies of Luna have been published — the definitive one is by Professor Vivencio Jose of the University of the Philippines (1999). However, none of the published biographies have dealt much with Luna's science career. What is known is that his family sent him to Spain to further his studies in chemistry and pharmacy.

Luna received his bachelor's degree in 1881. He had an early interest in the chemical and pharmaceutical sciences which his mentors at the Ateneo de Manila and UST did not fail to notice. At UST, he won first prize for the essay "*Dos Cuerpos Fundamentales de Quimica*". Luna did not finish his degree in UST and instead continued his studies in Europe, earning a Licentiate in Pharmacy from Barcelona and a doctorate from the Universidad Central de Madrid in 1893 (Jose, 1999). Luna was the first Filipino to be sent by the colonial government on a doctoral scholarship or commission. Part of the scholarship obligation is for the grantee to return to the Philippines to head the public health bureaucracy.

Antonio Luna became the Municipal Chemist of the City of Manila, having passed the qualifying exam upon his return from doctoral studies in Europe in 1894. As the municipal chemist, Luna did studies on food sanitation and quality, therapeutic properties of hot springs and the use of blood in criminal forensic investigations (Jose, 1999). His notable scientific papers at this time included "*Notas bacteriologica y experimentales sobre le Gripe*" which was published in the *Revista Farmaceutica Filipina* and the comprehensive work on water chemistry "*Memoria sobre analisis de las aguas termales de Sibul*" (Santiago, 1994b).

At this point I have to say that Luna was not the only Filipino *ilustrado* to have been sent to Spain for the science doctorate. Francisco Liongson received a doctoral scholarship in medicine to study cellular mediated immunity three years after Luna (Reyes, 2008; Santiago, 1994a). Like Luna, Liongson was expected to return to the Philippines to improve the public health system. He was with the Propaganda and returned to the Philippines in 1895. With the outbreak of the revolution, he joined the *Katipunan* and was appointed as chief of the medical corps of the Revolutionary Army. Upon establishment of American sovereignty in 1902 Liongson headed the medico-legal office during the American regime and later ran for the Senate in 1916 (Santiago, 1994a). Ironically, Liongson would die three years later due to anthrax, a disease which was a focus of his doctoral work.

Liongson and Luna are the first in the long line of Filipinos who were sent by the government to doctoral studies in the Metropolis in order to assume, upon their return, responsible positions in the bureaucracy. But unlike most of those who returned, Luna continued doing scientific research and was internationally recognized for doing so.

The question that historians have to ask is how Luna's scientific training made him into the revolutionary general he is remembered for. This question may be answered by reading his writings at this time of his life. Unfortunately, this may not be answered since Luna's diaries and laboratory notebooks went up in flames in a fire that razed a Manila art gallery in 1984. Luna's notebooks survived the Philippine American War and World War II but were eventually lost in the aforementioned fire.

While a pharmacy licentiate student in Madrid in 1889, Luna wrote a series of essays of his impressions of Madrid life and society which originally appeared in the Filipino propagandist newspaper *La Solidaridad* under the the pen name "*Taga-Ilog*". The essays were published as a single volume in 1891 under the eponymous title "*Impresiones*". Luna dedicated this work to his elder brother Juan.

The theme of "*Impresiones*" expressed through satire and irony the conditions in the metropolis, the state of tenements, the women, public infrastructure and even the kind of clients in Madrid's café society. Luna laid a critical eye on these social conditions and he being a Spanish citizen of the colony was initially disheartened to learn the backwardness of Madrid and Madrid society as not befitting of a capital of a European nation. The citizen of the colony always had the impression that the metropolis was superior to the colony in all its aspects, especially in science, technology and culture. And this was reinforced by the writings of Spanish travelogue writers like Francisco Cañamaque who had disparaging accounts of conditions in Manila and the Philippine colony and its inhabitants (Cañamaque, 1879).

One aspect is evident. It is within this training of scientific objectivity that Luna argued for Filipino autonomy within the Spanish metropolis. A common political theme of the Propaganda is that the Filipino people were not ready for revolution as a way of obtaining national independence. Independence for the Propagandistas will be achieved by negotiated reform proposals with Spain. By August 1896, this theme had become moot, as the Philippine Revolution had started under the leadership of Andres Bonifacio of the Katipunan revolutionary movement. Bonifacio sought the seizure of the walled city of Manila in order to establish an independent government (Salazar, 1994).

Luna's insistence on method and rationality is expected for a scientist. These are central to the idea of the Reform and the enlightenment ideas of the *ilustrados*. Jose Rizal's letters from internal exile in Dapitan, Mindanao to the Jesuit priest Pedro Pastells reveal the dialectic and rational basis of his philosophy and theology. These extended to Rizal's idea of what science is and its rejection of scholasticism, so much evident in chapter 11 of *El Filibusterismo* (Bonoan, 1994). Luna the scientist did not explore theological aspects unlike Rizal. But we do know that he read Kant and Karl Marx from his few surviving correspondence.

Rationality also touched the religious sphere. It will be a core doctrine in the religious schism to follow in 1902 with the establishment of the *Iglesia Filipina Independiente* (De Achutegui & Bernad, 1960). This is within the philosophical tradition of the Propaganda.

THE CONTEXT OF LUNA'S DOCTORAL RESEARCH

Luna did his research when the environmentalist determinist idea of European susceptibility to tropical infections was the accepted paradigm but was undergoing a shift in the last three decades of the 19th century. This was due to the Koch and Pasteur germ theories. These new paradigms were taught in the newly established Faculties of Pharmacy, Medicine and Surgery of the University of Santo Tomas (UST).

Luna's initial interest was in the bacteriology of water (to which he had been exposed by his training and association with Anacleto del Rosario in UST) but changed his research topic to the study of malaria. Luna's doctoral thesis "*El hematozoario del paludismo: su estudio experimental*" was published as a treatise in 1893. The change in research focus was likely to have been influenced by his mentor at the *Institut Pasteur*, Elie Metchnikoff. Metchnikoff's influence on research direction is even greater in the career of Francisco Tongio Liongson, whose research was on cellular immunity. Metchnikoff laid the basis of modern scientific theory on cellular immunity (Kaufmann, 2008).

Luna's "*Hematozoario*" is on elucidating differential diagnosis and the ontogeny of the malarial parasite *Plasmodium* in human blood. The *raison de' être* for the doctoral thesis is one of clinical necessity as Luna writes in his abstract.

In this development in establishing the transmission of malaria by experimental evidence, where does Luna's doctoral thesis fall in the context of theory and application of medical advances in the 19th century? Luna wrote his thesis when the pathogen responsible for malaria, *Plasmodium* had been definitely identified (Cox, 2010). Luna gives a thorough review of the science starting with the original, classical and medieval assumption that it was "bad air", miasma or "*mal aria*" as the causative agent. Luna however preferred not to use the term "malaria" following Laveran but instead used "*paludismo*". Laveran was of the opinion that "malaria" has a superstitious etymology and unsuited for scientific terminology (Bruce-Chuvatt, 1981). With his discussion of Koch's germ theory, Luna then gives a thorough review of *Bacillus malariae* or cryptogams as blue green algae as possible agents. He then cites studies that refute these hypotheses using tests of the Koch postulates in the first chapter of the thesis.

Luna was much aware of the Third Koch Postulate which deals with inoculation of the pathogen into a healthy animal model to cause the disease and its symptoms. He asks his first scientific question

"Pero, ¿puede afirmarse de manera absoluta la reproducción de la citada enfermedad por el procedimiento de la inoculación?"
(El Hematozoario, p. 17)
(*Is it possible to absolutely confirm the replication of the disease in patients by inoculating them?*, translation mine)

In the thesis, he wrote a review on the history of the malaria, taking great care to cite the latest research, which showed his acceptance of the new paradigms. A scientific understanding of the etiology of malaria was made possible by the wide acceptance of the germ theory of disease as a paradigm. Louis Pasteur and Robert Koch experimentally demonstrated this in 1878 and 1879. Bacteria as an agent of infection had long been suspected but not experimentally demonstrated. However, the infectious agent of malaria was not known and the default hypothesis was that bacteria caused it. One reason is that an early bacterial isolate from the Pontine marshes near Rome was the causative agent in a malaria like fever that caused spleen enlargement. Consequently the agent was called *Bacillus malariae* (Cox, 2010). Charles Louise Alphonse Laveran in 1880 isolated the *Plasmodium* parasite in blood, thereby falsifying the theory that malaria was bacterial in nature (Laveran, 1881).

While Laveran had incriminating circumstantial evidence that mosquitoes were the vectors for infection, there was no direct proof that indeed it was. It had to be demonstrated that the parasite was found in the mosquito. And if it was, what would the parasite look like? Will the parasite be different in morphology in its life stages? And how will it be possible to differentiate the life stages using microbiological techniques? Laveran had observed this differentiation in life stages and through hematological studies of 200 patients he was able to correlate this with the symptoms of malarial fever. However, this did not convince physicians—most especially Louis Pasteur and the Italian physicians studying the disease—since it was possible that what he observed were disintegrating corpuscles.

These questions are those proposed by the Italian school of malariology composed of the physicians Camillo Golgi, Ettore Marchiafava, Angelo Celli, Giovanni Battista Grassi, Amico Bignami, and Giuseppe Bastianelli (Cox, 2010; Golgi, 1886, 1889; Majori, 2012). All these scientists were cited by Luna. The Italian malariologists in 1898 would demonstrate that the *Anopheles* mosquito was the vector in human malaria (Grassi, 1900; Grassi, Bignami, & Bastianelli, 1899).

Malaria was a serious public health concern in 19th century Italy with 2 million reported cases in a national population of 30 million and a death rate of 15,000 to 20,000 per year (Majori, 2012). The new government of the newly unified Italian state (1881-1886) instituted a malaria control program that focused on reclaiming marshes to combat the disease. In this period, the Italian Parliament passed laws regulating the distribution of quinine and making arrangements for its free distribution to the populace. This was implemented through the municipal physicians. But the goal of effective control was contingent on identifying the *Anopheles* vectors in the human population which Grassi, Bignami and Bastianelli did in 1898 to 1899. With the confirmation that *Anopheles* mosquitoes were the vectors, then insect control became the most important public health measure to control malaria infection worldwide (Bruce-Chwatt, 1988). And by the time the United States assumed complete sovereignty over the Philippines by establishing civil government in 1902, one of the major public health concerns was to control malaria by eradicating mosquito breeding places (Anderson, 2006; Heiser, 1906; Heiser, 1936).

The main corpus of Luna's thesis is essentially on differentiating the various forms of the malarial parasite in blood and to test the hypothesis of the sole origin of the various observed forms of the parasite in human blood. Luna supports the single origin hypothesis and that these transformations of the original forms using Darwinian evolutionary terminology are correlated with the manifestation of the disease in patients. Luna read and cited the results of Camillo Golgi's (1886) studies on the periodicity of malarial fevers, the tertian and the quartan periodicity. These fevers were observed to coincide with the rupture of blood cells releasing the merozoites. He then cites Grassi (1900) who described two species of *Plasmodium*, *P. vivax*, and *P. malariae*. This shows that Luna was familiar with the immunological theory of his mentor Metchnikoff. With the immunological theory this established by observation and experimentation, Luna then tests diagnostic staining of these forms in human blood and the possibility of laboratory culture with the aim of determining which form is responsible for the tertian and quartan periodic fevers. He improves on a methylene blue and Eosin based staining developed by Romanowsky (Leishman, 1901), which was further developed by Giemsa and which now remains the standard in histopathological blood film diagnosis of malaria (Kong & Chung, 1995; Moody, 2002). Luna was prescient enough to recognize that in vitro culture of *Plasmodium* is necessary to attribute which form of the merozoite is causative of the tertian and quartan periodic fevers. When the merozoite is isolated, then Luna could have tested Koch's Third Postulate by inoculation in rabbits. Luna focuses on the flagellated parasite and notes flagellar motility and tries to develop techniques for in vitro culture. However, this was largely unsuccessful.

Luna's doctoral thesis contributed to the gold standard for malaria diagnostics even today, the blood film method. While molecular techniques have fine-tuned diagnostic techniques, the blood film technique continues to be the most practical as it helps save thousands of lives in countries.

COLONIAL SCIENCE AND HEALTH POLICY, THEN AND NOW

With the opening of the Philippine colony to international trade, the colony began to see the establishment of industries that processed agricultural produce into exportable commodities especially in cordage and sugar. Much of the investment here came from the British and the Americans,

who established trading houses (B. Legarda, 1957; B. J. Legarda, 1999). New technologies were introduced by the Americans as economic historian notes in rope factories in Manila's *arrabales*. Also a realization in Spain that the country had lagged in industrial development compared to Britain, led to leading members of the Spanish aristocracy like Pedro de Campomanes establishing private associations called "*Sociedad de los Amigos de Pais*" starting 1765 whose aim is to improve the economies of the colonies. The *Sociedad* was most active in Puerto Rico, Venezuela, Cuba, Mexico, Chile and the Philippines.

In the Philippines, the first *Sociedad* was established with government support by the Governor General José Basco y Vargas in 1771. The Philippine *Sociedad* focused on making the agriculture sector of the colonial economy more competitive. It focused in developing the betel nut, tobacco, metallurgy and liquor industry. The colony established its first paper mill in 1825. This drive towards competitiveness was largely driven by British competition as by then the British had already occupied India. To encourage innovation, the *Sociedad* awarded prizes (Legarda, 1999).

The Philippine *Sociedad* in no doubt contributed to innovation to agriculture and industry in the Philippines and with it came the diffusion of Enlightenment ideas to a rising Indio merchant class. In 1842, Spanish diplomat Sinabaldo de Mas wrote a communique to Madrid on the condition of the colony and recommended that the colony be emancipated or at least transferred to British rule (De Mas, 1843). This was even if de Mas noted the economic advances of the colony as a result of the *Sociedad*.

The *Sociedad* was the first state-sponsored organization to advise the colonial government on technology policy. But by the 1850s the colonial government realized the importance of public health in the governance of the colony that it started to establish what we can call a modern public health system. The focus was preventive. Although Spain had ordered mandatory vaccination in her colonies as early as 1806, this was hardly implemented in the Philippines even if the central board of vaccination in Manila was producing and distributing smallpox lymph. Vaccination and not hygiene remains as the most interventionist feature of colonial state medicine (Anderson, 2006).

This interventionist characteristic of colonial state medicine is one of the major reasons for the establishment of a medical school in Manila. In 1871, the University of Santo Tomas (UST) in Manila established a faculty of medicine and surgery and a faculty of pharmacy by virtue of the Moret Decree that mandated the establishment of secular medical schools (Dayrit, Santos-Ocampo, & Eduardo, 2002). The religious establishment in the Philippines opposed secularization but complied with the decree by establishing the faculty in a Catholic university. Thus for the first time, the training of physicians and pharmacists was done in the Philippines. Among the courses taught were on infectious diseases. With this development, physicians were sent to the far flung provinces of the Philippines for at least a year and the government required physicians to send medical statistics to Manila (Boncan, 2016). The first epidemiological statistics on malaria and leprosy were then published. UST however was not empowered to grant doctorates in medicine and pharmacy as the purpose of the licentiate programs is to produce practitioners for the colony. The doctorate was an academic requirement purely for a professor's teaching appointment at a university. Candidates for the doctorate had to enroll in and submit a thesis at a European university and for most Filipinos that was the Universidad Central de Madrid (Santiago, 1994a).

The public health infrastructure when Spanish sovereignty ended in the Philippines in 1898 was impressive for meeting the objectives it had in the 30 years after establishment of UST's Faculty of Medicine and Surgery. All provinces of the country except one had a medico titular or a government physician. The majority of the doctors were graduates of the University of Santo Tomas. A modern quarantine system was in place and municipal chemistry and bacteriology laboratories were established. UST trained pharmacists like Anacleto Del Rosario developed innovative microbiological techniques (Reyes, 2008; Santiago, 1994b). But given the political and economic realities, it was largely ineffectual (Boncan, 2016).

Luna's appointment as municipal chemist of Manila and his "commission" to do pharmacy research as well as his doctoral scholarship in Europe is a recognition of the colonial government of the importance of science in alleviating the problems of the colony (Boncan, 2016) which has its origin in the goals of the *Sociedad Economicas*. Luna was not the only one to receive a scholarship. As mentioned earlier a Kapampangan, Francisco Tongio Liongson went to the Universidad Central de Madrid to do doctoral research in medicine.

Thus we find Luna's and Liongson's training as well within this colonial state health interventionist paradigm which—even the short-lived Filipino Republic adopted (Anderson, 2007)—will continue even after American occupation of the Philippines. This is readily seen in the nature of the research topics both men chose. We also find Luna's motivations in finishing the doctorate and doing medical research afterwards fully within this context. Luna wanted to improve the capability of Filipino physicians to diagnose malaria.

The Filipino Republic recognized the importance of establishing faculties of medicine and pharmacy in its short-lived national university, the *Universidad Literaria de Filipinas* on October 19, 1898 in Malolos. The university was also an assertion of national sovereignty and the idea that education in the sciences is necessary for securing the idea of independence according to Dr Antonio Ma. Regidor, who was interviewed on the necessity of a Philippine university (Jamias, 1962).

Antonio Luna was appointed Dean of the Faculty of Pharmacy and Francisco Tongio Liongson as professor of medicine. These faculties were to provide *medico titulares* to the liberated provinces. Had the university survived, it is likely that these faculties would have supported research like what UST supported with the establishment of its medical and pharmacy faculties, 30 years earlier. Luna and Liongson with their research training would have led the effort, if the Philippines remained independent. Liongson's career shows that it was necessary to enter politics in order to secure the independence of the Philippines not through a revolution but through a parliamentary struggle. However, it must be recognized that Liongson as a member of the *principalia* of Pampanga had to preserve the privileges of his class. Liongson did not continue with scientific work but authored bills on public health that mandated research on diseases like rinderpest which decimated Luzon's livestock industry. Liongson ironically died of anthrax in 1919.

The War of National Liberation resulted in the near total breakdown of the public health system (Escalante, 2016) though a few doctors such as the municipal doctor of Pasig, a town 15 km east of Manila, was able to treat combatants on both sides. The Americans had to establish a new public health infrastructure. One key aspect is to ensure the health of the occupation army. The US Army was much concerned about the health of the troops that it had

to conscript Filipino doctors—many of whom had sympathies for the Filipino revolutionaries. The American occupation also saw the reexamining of the medical and public health curricula so that it would conform to American health ideologies. However, it would take a few years before it conformed to American standards (Santiago, 1994a, 1994b).

American health and science policy was to secure the occupation both in its military and civil aspects. The American military government wanted to prevent the sanitation disaster the US army experienced in the occupation of Cuba and immediately employed the services of UST trained Filipino doctors (Escalante, 2016). With the establishment of civil government in 1902 and William Taft's assumption of the Governor Generalship, the civil and bureaucratic institutions of the modern Philippine state were laid in science and medicine. These are the Bureau of Science and the Bureau of Health.

The key health ideology of American occupation can be summarized as "washing up the Orient" (Escalante, 2016; Heiser, 1906; Victor George Heiser, 1936) which meant segregation of the Filipinos who were assumed to harbor infection from the Americans (Escalante, 2016). The first director of the Philippine Bureau of Health Dr. Victor Heiser was appointed immediately after the establishment of civil government in 1902. Heiser considered the building of health infrastructure as a lesser priority than education of Filipinos on public health and the regulation of Filipino social relations to ensure that the American objectives of their occupation would succeed. The American health authorities burned down the workingman's district of Tondo, Manila to ensure this objective (Escalante, 2016). American ideology on hygiene would necessitate the establishment of the Philippine Medical School in 1905 which later would be one of the first colleges of the University of the Philippines (UP) upon its foundation in 1908.

Scientific research under the Americans focused on tropical diseases. This was the focus of the newly established UP that not surprisingly, the first research doctorate the new university awarded was on tropical medicine and public health in 1918 (Jamias, 1962). Research in tropical medicine continued on until the eve of Japanese occupation of the then autonomous Philippine Commonwealth.

Medical science will be central to scientific research in the Philippines as well as research on maximizing the utility of Philippine natural resources in accordance with the US colonial economic policy. The results of this research were published in the Philippine Journal of Science, Asia's oldest existing scientific journal.

With the Philippine Independence Act passed by the US Congress in 1934, a Commonwealth of the Philippines was established with a constitution ratified by the people. This Commonwealth was a ten year preparatory stage of self-government before independence is recognized. Unlike the US Constitution from which much of it was modelled, the 1935 Commonwealth Constitution is remarkable for declaring science and technology as a principle of state. In this way, the leaders of the independence movement, Manuel Quezon and Sergio Osmena, elected subsequently as President and Vice President of the Philippine Commonwealth ensured that the *ilustrado* ideal for science and technology was made part of the nation's basic law. The *ilustrado* ideal of nation had science and technology as a central theme, as agents of modernity which can provide the independent nation limitless opportunities for charting its future. The subsequent 1973 and 1987 Constitutions have preserved the same principle.

But even with that ideal, there was a continuity between the Spanish colonial and American colonial science and economic policy in the Philippines which largely continues to the present. Seventy years after independence, Filipino science is still very much dependent on the support from its former colonial rulers and more advanced economies in the Asian region, most notably China, in the development of scientific manpower, capacity and research direction. This direction for science policy is more advantageous for the world powers and increasingly involves geopolitical and military aspects. It is couched in the language of "internationalization", "collaboration", and "globalization" for competitiveness and integration.

How would the scientist turned revolutionary general, Antonio Luna would make of this if he were alive today is anyone's guess.

But perhaps a clue would lie with what clueless Washington DC bureaucrats recommended in 1902. They wanted Luna to serve as a chemist to head the American laboratory in Manila. By then Luna was in the pantheon of Filipino heroes.

NOTE

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