philippine studies

Ateneo de Manila University • Loyola Heights, Quezon City • 1108 Philippines

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Philippine Studies vol. 55, no. 3 (2007): 287–318

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This essay surveys the history of science and medical research in the Philippines from the Spanish conquest through the 1970s. It touches on the links between science, religion, the colonial state, and national aspirations. In different periods the production of scientific knowledge has been treated as an index of personal salvation, civilization, modernity, and national development. More recently, science has functioned as a civic conscience for the troubled nation-state. This essay is intended as a work of synthesis and overview, providing a tentative framework for further analysis.

KEYWORDS: SCIENCE · RESEARCH · PHILIPPINES · COLONIAL · NATIONAL

PHILIPPINE STUDIES 55, NO. 3 (2007) **287–318**

Writing of nationalism, Benedict Anderson (1998, 227) once noted "few countries give the observer a deeper feeling of historical vertigo than the Philippines." The history of science in the Philippines produces a similar giddy sensation—indeed, one might easily substitute apparent conundrums of scientific development for the historian's strange political and social juxtapositions. After three hundred years of Spanish clerical colonialism, fewer than 10 percent of local inhabitants were literate in Spanish, yet Catholic religious orders had supported pioneering natural history and astronomical research, and from the seventeenth century even sponsored universities in the archipelago. Thus, in the 1880s, José Rizal (1886/1990, 318), novelist, medical doctor, and nationalist, reflected that "the Jesuits, who are backward in Europe, viewed from here, represent Progress; the Philippines owe to them their nascent education, and to them the Natural Sciences, the soul of the nineteenth century." The withdrawal of Spain in the 1890s did not do much to rectify such unconventional associations and oppositions. After 1898 the United States established government laboratories and greatly expanded secular science education, but many Americans continued to disparage mestizo contributions to science and to question more generally Filipino capacity for virile, modern research.[1] Americans in the colonial service often represented the Spanish colonial period as a howling wilderness for science, yet the new American scientific order was built in part out of earlier Jesuit institutions: the Manila Observatory, for instance, was simply renamed the Weather Bureau. And then, in the 1920s and 1930s, as nationalist, English-speaking Filipinos took over the laboratories they often devalued their American training and affiliations, preferring to find earlier mestizo models for their work, even if these putative antecedents had written in a language and a style now alien to them.

Science in the Philippines followed no straight line of development from primitive to sophisticated, or from absence to mere backwardness, or even from local to universal in orientation. Some sort of naturalistic investigation, some effort to order and classify the natural world, is found in the archipelago from the beginnings of human settlement. After the arrival of Miguel López de Legaspi and his small band of *peninsulares* in 1565, such studies rapidly acquired a more formal cast, taking the shape of standardized observations collected in portable texts, authorized and circulated through religious orders, or accumulated by a few foreign sojourners on voyages of

investigation. The arrival of the laboratory late in the nineteenth century, and its institutional development under the American regime in the early twentieth century, tended to displace older natural philosophy and natural history, although experimentalism never completely substituted for collection and classification. American scientists trained a cohort of Filipinos in laboratory methods, and by the 1930s, in advance of national independence, a largely secular local elite had gained control of scientific research in the Philippines. Change abounds, certainly, but to describe this change simply as progress, to imply a relentless improvement in knowledge and method, would constitute a sundering of the complex and fragile local entanglements of science and its circumstances.

I am not interested here in documenting how science in the Philippines might gradually have transcended its colonial or national setting; rather, I want to indicate what is at stake when one does science, or natural history, in a specific location. My concern therefore is with the various meanings of science in the Philippines, with the cultural force of certain ways of studying and interacting with the body and its surroundings. In particular, I would like to look at how local needs and commitments shaped the investigator's choice of subject and mode of investigation; and, conversely, how a commitment to research, and a desire for external expert validation, informed and helped to frame the understanding of the locale. Science should neither be reduced to its local circumstances, nor represented as blithely transcending them. Admittedly, it is likely that science has never meant anything much at all to most people in the Philippines, as elsewhere, but those who engaged in scientific study, or promoted it, evidently believed that science would, or should, become as significant to others as it was to them. It is possible that science, like poetry, has made nothing happen in the Philippines—nothing that would not have happened anyhow—but clearly religious and secular authorities expected that it would, or should, transform the archipelago and its people. Throughout the vertiginous history of the Philippines, then, one discerns at least a commitment to science, even if the form and the significance of this interest have varied considerably.

An Apostolic Colonial Science

In 1521 Antonio Pigafetta (1969, 1:105), an Italian gentleman who accompanied the expedition of Fernando de Magallanes, observed that on the island of Palawan:

> Trees are found there making leaves which, when they fall, are alive and walk. And these leaves are no larger or smaller than a mulberry, but not so long. Near the tail, which is short and pointed, they have on both sides two feet. They have no blood and if anyone touches them they run away. I kept one for nine days in a cage, and when I opened it, it went all around. They cannot, as I think, live on anything but air.

Pigafetta's description of Palawan leaf insects illustrates the sense of wonder that the natural world of the Pacific could elicit in European explorers. Many of the voyagers, and a few of the first Spanish settlers in the islands, were fascinated by grotesque creatures and sublime prospects. However, in the records of Magallanes's European discovery of the archipelago, and in other sixteenth-century accounts of the islands, there is no indication of any systematic investigation of the local inhabitants, flora, fauna, and geography. It was not until 1543 that the Spanish were able to reach the archipelago from the west coast of New Spain (Mexico), and it took another thirty years or so before they found a safe, practical return route, and established the galleon trade (Schurz 1939). In 1571 Legaspi founded Manila on the island of Luzon as a trading center where Chinese silks were exchanged for Mexican silver and then sent through the Americas to be sold in Europe. Spanish officers and traders clustered in the walled city and, after the shock of the first encounter had waned, their interest in the surroundings soon diminished (Phelan 1959; Cushner 1971; McCoy and de Jesus 1982).

In the provinces, the Spanish clergy assumed control over the indigenous population, with Dominicans, Franciscans, Augustinians, Recollects, and Jesuits acting as both religious and secular authority. The religious orders sought to convert the largely animist inhabitants to Christianity, and they did so through use of a profusion of local languages, not Spanish. But even if spiritual matters received more emphasis than things material, effective proselytization required some knowledge of the people and the place. In the seventeenth century a few priests began to document the frequent earthquakes and to study volcanic eruptions. Some of the clergy reported on the more unusual Philippine animals and plants and, attired in heavy Spanish vestments, described the tropical conditions that they found so discomforting. In 1611 Fr. Blas de la Madre de Dios, a Franciscan, listed local plants of presumed medical value, but it remained unpublished; Fr. José de Valencia (1669), another Franciscan, and Fr. Francisco Ignacio Alcina, S.J. (1668), put together similar manuals, but these too were never published

(Merrill 1936). In general, the Catholic Church's interest in nature during this period was subordinated to its apostolic mission, and the products of its peculiar secular interest rarely circulated beyond the religious orders.

In the late sixteenth and early seventeenth centuries, the same religious orders established many of the institutions that would shape the study of nature during the Spanish period. The San Francisco Corporation founded the San Lazaro Hospital in 1578, initially for the poor, but after 1631 for the increasing number of lepers. In Manila the Hospital de San Juan de Dios, for the care of poor Spaniards, opened in 1596; and in Cavite the Hospital de San Jose was established in 1641. For a century or more, these institutions remained religious refuges rather than secular medical workplaces. The major religious orders also set up colleges and universities for the small criollo and mestizo community. The Jesuits, prompted by Fr. Diego García, the visitor of the order in the Philippines, opened the Colegio de San José in 1601, and retained control of its teaching until their expulsion from the archipelago in 1768. The Dominican Corporation established the University of Santo Tomás in 1611, and it soon became the major institute of higher education in the islands. The teaching emphasized theology and philosophy, but the order added a law faculty in 1737, and eventually permitted the organization of faculties of medicine and pharmacy in 1871. In 1875 the Colegio de San José was incorporated into the University of Santo Tomás as the College of Medicine and Pharmacy (Bantug 1953).

Despite the institutional dominance of Santo Tomás, the Society of Jesus led the meager efforts to study nature in the Philippines. The Jesuits introduced mathematics and physics into the curriculum at their college, and many of the more influential natural historians of the Philippines were associated with the order. In general, Dominicans continued to focus on the *vita contemplativa*, regarding study as a means of preparation for reflection on divinity, and they enforced strict adherence to theological doctrine. For the Jesuits, however, education had become a means of gaining influence, of building confessions, and for them study might represent a separate path toward salvation. The Society of Jesus had come to favor an active engagement with the world, giving it a special respect for practicality and diligence (Feldhay 1987; Harris 1989). Until their expulsion from the Philippines, Jesuits often demonstrated openness to local experience, unusual industry in collection and observation, a tendency to find a divine order in nature, and distrust of more skeptical or heretical explanations. Their studies of man

and the natural world became a node in a long-distance scientific network, permitting their observations to be collated and used to impress the order's European friends and patrons and to demonstrate, ultimately unconvincingly, their usefulness to secular authorities in Spain and the Philippines (Harris 1996). When they returned to the archipelago in 1859, having lost their curacies in the provinces, the Jesuits redoubled their educational and investigatory efforts (de la Costa 1959). Perhaps the most striking illustration of renewed Jesuit dominance in Philippine scientific work was the establishment of the Manila Observatory in 1865.

Until the nineteenth century, priestly studies in Philippine anthropology, botany, zoology, and geography remained scattered and unsophisticated. Fr. Pablo Clain (Paul Klein), S.J., put together some botanical descriptions and a guide to medicinal plants early in the eighteenth century (Clain 1712/1857); and Fr. J. G. Kamel, S.J., for whom Linnaeus named the camellia, undertook the most extensive analysis of Philippine material to date (Kamel 1693–1704). However, in his *Species Plantarum* Linnaeus derived few binomials from Philippine references, and it was not until the early nineteenth century that Philippine material, by then circulating more commonly in Europe, began to figure in botanical works of a systematic character, such as A. P. de Candolle's *Prodromus* (1824). Studies in zoology were even more rare, apart from occasional descriptions of distinctive local fauna and casual observations on the acclimatization of horses and cattle (Bankoff 2001). Pigafetta's account of the leaf insect may be the most detailed entomological investigation in the islands until the twentieth century.

The authors of the *Encyclopédie* commented that, while the Philippines was one of the more beautiful archipelagos of the Orient, the Spanish had shamefully neglected to examine and report on its features (Anon. 1765). An Englishman visiting Manila early in the nineteenth century complained that, with "jealousy of foreigners exceeding even the bounds of credibility, she [the Philippines] invariably refused them admittance, whether for scientific or commercial purposes" (Piddington 1828, 68–69). The liberal coffee planter lamented that, "while the torch of science has blazed in the western hemisphere, from Greenland to the Antarctic, bearing with it light and life, and hope, and blessings, few are even aware how very much it has yet to illumine in the East!" (ibid., 104). Most visitors found the Spanish residents "exceedingly indolent," and deplored the lack of books in the archipelago (MacMicking 1967, 47). Sir John Bowring (1859/1963, 118), visiting from

Hong Kong in the 1850s, was amazed that the University of Santo Tomás was still concentrating on philosophy, Latin, and rhetoric, giving no attention at all to the natural sciences. Even in the 1870s Fedor Jagor (1917, 26) lamented that in the Philippines "the pompously celebrated religious festivals were the only events that sometimes chequered the wearisome monotony." According to Jagor, the botanical gardens, established in a perfunctory manner in 1858, had "soon faded away"—though in fact they had simply moved to a new site in Santa Mesa. The visiting critic described a few thousand "uneducated, improvident, and extravagant Spaniards" (ibid., 29) mixing promiscuously with locals who "imitate everything that passes before their eyes without using their intelligence to appreciate it" (ibid., 35). Existing in the easiest of natural conditions, Filipinos seemed passive to resist education and science.

Science and the Spanish Colonial State

Jagor's wry orientalism misrepresented a more complex engagement with science in the Philippines from the late eighteenth century onward. Although religious orders continued to dominate the sciences, and indeed they conducted more investigations of natural history than ever before, tensions between secular and religious authorities, recurrent in Spain, had begun to exert an influence on the Philippines. In particular, there were glimmerings in the Pacific of *la Ilustración*, the Spanish Enlightenment, with its distrust of well-worn doctrine, emphasis on observation, and embrace of Montesquieu, Voltaire, Rousseau, and Diderot. In Spain the scientific work of scholars such as Gerónimo Feijoo, a Benedictine and Lockean empiricist, had received support from the Bourbon monarchy; but the Society of Jesus denounced such "Jansenist" deviations, regarding the monarchy and Ilustración as challenges to the authority of the pope (Herr 1958). In 1767 Carlos III expelled the Jesuits from Spain, and soon afterward they were also forced out of the Philippines. The British had occupied Manila between 1762 and 1764, but after the restoration of Spanish control a succession of liberal governors-general reflected the new mood in Spain and attempted to promote education, agriculture, and commerce in the archipelago. José Raón (1765–1770) coined the first copper money, expelled the Jesuits, and attacked Moro pirates. His successor, Simón de Anda y Salazar (1770–1776), criticized abuses by the friars, began the secularization of curacies, and condemned the medieval teachings at Santo Tomás.

José Basco y Vargas (1776–1788) was perhaps the most energetic and enlightened of the late-eighteenth-century governors-general. During his unusually long occupancy of the post, he reorganized the schools, checked Moro piracy, and tried to develop agriculture through the establishment in 1780 of the Real Sociedad Económica de Amigos del País. Based on the economic societies, also called *amigos del país*, which had cropped up throughout Spain and the empire since the 1760s, the Manila amigos del país aimed to foster research and development in agriculture, mining, and manufacturing. The society's record was mixed. By the end of the century it was dormant; in 1819 it was reestablished, but was soon nearly paralyzed by the 1820 cholera epidemic. By the middle of the century it was quiescent again, yet it resumed work, feebly, in 1860. Still, the society contributed to the support of Fr. Manuel Blanco's *Flora de Filipinas* (1837), perhaps the major Philippine botanical publication of the nineteenth century (though discounted by American botanists in the following century). It gave rewards for successful innovation in farming; introduced Chinese martins in the 1850s to control locusts; compiled a library of 3,500 volumes in arts, sciences, and agriculture; as well as established a museum of natural history. The society also maintained an interest in the monitoring of plant and animal introduction, such as the success of tobacco and cacao in the late seventeenth century, coffee and sugar in the early nineteenth century; and the failure of mulberry bushes and silkworms in the late eighteenth century (Lopez Rizal 1936).

Communication with Spain and the rest of the world improved slowly during the nineteenth century. In 1785 the Real Compañía de Filipinas was chartered to expand commerce between Manila and Spain and provide an alternative to the galleon trade with the Americas, which was finally abandoned in 1815 with the fall of Acapulco to Mexican insurgents. The government opened the port of Manila to foreign commerce in the 1830s, and granted access to Iloilo, Zamboanga, and Sual in 1855, and to Cebu in 1863. The first steamships arrived in Manila harbor in 1848. From 1868 vessels could use the Suez Canal, reducing the journey between Europe and the Philippines from four months to one month by steamer. In 1880 cable linked Manila more closely to Europe than ever before. Improved connections with Spain reduced the influence of foreign traders in Manila and encouraged Spaniards to move to the islands. In 1810 there had been fewer than 4,000 peninsulares and Spanish mestizos in the archipelago, mostly clustered in Manila (compared with many million *indios* throughout the

archipelago). Four thousand peninsulares and more than 10,000 mestizos and criollos lived in the Philippines in 1876; but by 1898 the numbers had swelled to more than 34,000 Spaniards, including 6,000 government officials, 4,000 army and navy personnel, and 1,700 clerics (LeRoy 1907).

The conditions in the capital were changing during this period. During the 1850s, the government put sewers underground in Manila. In 1882 the Carriedo waterworks opened, and the first telegraph lines appeared in 1873, which was followed by the installation of telephone lines in 1890 and an electric light system in 1895. In addition, the school reforms of 1863 had established a framework, still grossly inadequate, for a state system of primary education (Alzona 1932). The Jesuits at the Ateneo de Manila were giving instruction in natural philosophy, and the colleges and universities, still few in number, began to teach natural sciences and medicine. By 1870 improvements in education and in communication had encouraged a new generation of mestizos and criollos to take an interest in the sciences.

Until this generation expressed its enthusiasm for science in the late nineteenth century many of the more significant nonreligious contributions to knowledge of the Philippines still came from visitors to the islands. Le Gentil had passed through the archipelago in the course of making astronomical observations and showed some interest in local features. Predictably, he too noted the antagonism of Spanish authorities toward scientific workers (Le Gentil 1964).[2] A few years later, in 1789 an expedition left Cadiz, Spain, under the command of Capt. Alejandro Malaspina, with the goals of collecting botanical and zoological specimens, and studying meteorology and other factors affecting navigation (Kendrick 1999; Palau Baquero 1991; Mallan 1988). Inspired by the voyages of James Cook and Jean François de Galaup de la Pérouse to the Pacific, the Spanish government hoped that the findings of Malaspina's expedition might contribute to Spanish prosperity as well as give useful information about the new British colonies in the region (Engstrand 1981; Frost 1996). When the corvettes *Descubierta* and *Atrevida* arrived in the Philippines in 1792, the naturalists from the ships—especially Thaddeus Henke and Luis Née—ventured into the interior of Luzon to collect plants and animals, while those who stayed on board conducted hydrographic surveys and gravitational experiments. However, on his return to Spain, Malaspina, a naïve yet ambitious *ilustrado* who was familiar with the theories of Galileo and Newton and admired the works of Descartes and Voltaire, so irritated the government that he was imprisoned and therefore unable to circulate the results of the voyage.

Many other collectors would follow in the nineteenth century. Eugène Perrottet in 1818 collected and studied Philippine botanical material of economic value, preserving some of it in Paris (Perrottet 1824; Robinson 1909). In 1843 the Wilkes United States Exploring Expedition botanized widely in Luzon and sent a major collection of specimens to the United States National Herbarium (Gray 1854; Merrill 1908). Hugh Cuming, a British conchologist, was perhaps the most assiduous collector of all. He roamed the Philippines between 1836 and 1840, sending more than 2,200 Philippine plant specimens, and a greater number of duplicates, back to Europe. Until the end of the nineteenth century most European botanists came to know Philippine flora through these collections; most general taxonomic works from the 1840s onward referred to Cuming's specimens (Melvill 1895; Merrill 1936).

From the 1870s local scientists, most of them not in religious orders (although many were peninsulares), took over the analysis of Philippine material. The arrival of Sebastián Vidal y Soler in 1871 marked the beginning of reliable local taxonomic work in botany, and of scientific forestry (Bankoff 2004). As chief of the Comisión de la Flora de Filipinas, Vidal was responsible for major classificatory and comparative studies, and was among the first to recognize the need for a local botanical library and herbarium (Vidal y Soler 1883). However, after his death in 1889 taxonomic investigation in the islands slowed down, and the herbarium he had established burned in 1897, so that "at the beginning of the American administration the assembled equipment for botanical work in Manila, both literature and specimens, had been destroyed, lost, or rendered inaccessible" (Merrill 1936, 511–12). After 1870 some attention also was belatedly given to zoological investigations, resulting in the publication of the *Catálogo sistemático de toda la fauna de Filipinas* (Elera 1895–1896). At the Mining Bureau, José Centeno y García (1885) and others studied the Taal and Mayon volcanoes (Abella y Casariego 1885) and performed mineral analyses; and in the Municipal Laboratory (established in 1888) Anacleto del Rosario (1895) and León Ma. Guerrero investigated the chemical composition of the waters of Negros and Luzon. Scientific and medical journals proliferated: the *Boletín de medicina de Manila* (1886), the *Revista Farmacéutica de Filipinas* (1893), the *Crónicas de ciencias médicas* (1895), and others. At Santo Tomás the College of Medicine and Pharmacy began to train students to use a microscope in the 1890s (previously they had

examined drawings of germs), and a Faculty of Science, with courses based on those in Madrid, opened in 1895 (Rodriguez 1936).

The most impressive research took place at the Jesuit Observatory. From the 1870s the observatory concentrated on the forecasting of typhoons, using meteorological instruments designed by an Italian Jesuit, Fr. Angelo Secchi (Bankoff 2006). Under the direction of Fr. Federico Faura, S.J., it added a magnetic section in 1887, which produced the first maps of the terrestrial magnetism of the archipelago; a seismic section in 1890, which gave one of the earliest accurate tracings of an earthquake; and an astronomical section in 1899 (Schumacher 1965).[3] The outbreak of the revolution curtailed most of these research and educational activities.

A growing number of mestizos and criollos in the archipelago began to call themselves Filipinos and to represent themselves as ilustrados, as they increasingly became committed to nationalism, science, anticlericalism, and political reform (Schumacher 1973; Ileto 1979). In part, the reform sentiment, expressed first in the Propaganda movement, derived from Spanish liberal and secular agitation, which had culminated in the revolution of 1868—just as the conservative reaction in Spain was echoed in the Philippines after the 1872 Cavite rebellion. But local factors also contributed. Improved commercial opportunities allowed the expansion of the middle class; ambitious and progressive Filipinos began sending their sons to France and Spain for higher education; talented local candidates resented the peninsulares who took most of the top government posts; and more efficient communication had helped to break down regional feelings in the islands. Furthermore, racial distinctions became especially marked toward the end of the century, and there emerged "a tendency to thrust the native aristocracy into a secondary place, to compel them to recognize 'white superiority,' to a degree not so noticeable in the earlier years of Spanish rule" (LeRoy 1907, 98). Initially, local ambitions and resentments found expression in moderate groups such as José Rizal's Liga Filipina, founded in 1892. A little later, Andres Bonifacio organized the Katipunan, an anticlerical and anti-Spanish brotherhood that in 1896 led an insurrection against Spanish control. The friars attributed disaffection to "Franc-Masonería," for them the epitome of everything troubling in modern life; the Spanish army attempted to suppress the rebellion with such brutality that even moderates turned against Spanish rule (LeRoy 1907). However, by the time Emilio Aguinaldo was able to declare the Philippine Republic in 1899, the United States had claimed the archipelago.

José Rizal was one of the leaders of the rising generation of nationalists. From the Jesuits at the Ateneo de Manila Rizal had received a solid grounding in the sciences—indeed, one of his teachers, Faura, later directed the observatory—even if he subsequently argued that Jesuit education had seemed progressive only because the rest of the Philippines was mired in medievalism. At Santo Tomás, studying science, he found that the walls "were entirely bare; not a sketch, nor an engraving, nor even a diagram of an instrument of physics" (Rizal 1891/1991, 141). A mysterious cabinet contained some modern equipment but the Dominicans made sure that Filipinos admired it from afar. The friars would point to this cabinet, according to Rizal, to exonerate themselves and to claim that it was really "on account of the apathy, laziness, limited capacity of the natives, or some other ethnological or supernatural cause [that] until now no Lavoisier, Secchi, nor Tyndall has appeared, even in miniature, in this Malay-Filipino race!" (ibid.). Still, it should be recalled that nowhere else in Southeast Asia was education available at such an advanced level (Schumacher 1975). In 1882 Rizal traveled to Spain to study medicine, and he later visited France and Germany. He was astonished and embarrassed by the political and scientific backwardness of the imperial power. In Europe medicine, political activism, and the writing of his brilliantly sardonic novels occupied most of his time, but after Rizal returned to the Philippines, and was confined at Dapitan, he also began collecting plants and animals, and discovered new species of shells (Bantug 1961). During this period, Rizal engaged in a copious, self-consciously enlightened correspondence with Ferdinand Blumentritt, the Austrian ethnologist, and translated into Spanish many of his works on the Philippines (Schumacher 1954). For Rizal a commitment to science and reason informed patriotism, and patriotism implied a scientific orientation to the world. Unimpressed, the clerical-colonial authorities executed the "First Filipino" in 1896.

The Gospel of American Colonial Science

Adm. George Dewey's victory over the Spanish fleet in Manila Bay on 1 May 1898, a few days after the outbreak of the Spanish-American war, signaled the entry of a new colonial power in Southeast Asia. Pres. William McKinley hurriedly arranged to send a military expedition to take possession of the Philippines but, by the time the United States army arrived later in 1898, Spanish authority had collapsed and Aguinaldo's rebel forces had taken control of most of the provinces. The commander of the Spanish garrison in

Manila surrendered to the expeditionary forces, and the opposing Filipino troops proceeded to dig in around the city. In the Treaty of Paris, signed on 10 December 1898, Spain formally handed sovereignty of the archipelago to the United States. For the next five years or more, American forces engaged in a bitter and brutal campaign against the Philippine "insurrectos" in order to secure the new possessions (Gates 1973; Miller 1983).

Americans were inclined to represent themselves as more reforming, progressive, and scientific than other colonialists (Stanley 1974; Owen 1971). Victor G. Heiser, the harshly efficient director of the Bureau of Health from 1905 until the end of 1914, recalled that, once American authority was asserted, "the microscope supplanted the sword, the martial spirit gave place to the research habit" (Heiser 1906, 245; Anderson 1999a). When touring the archipelago in 1909, governor-general W. Cameron Forbes (1909) reflected on the need to understand the territory:

> There is a fascination about unknown uninhabited islands off in these tropic seas. I feel, however, the lack of scientific knowledge. I'd like in these cases really to add something to the scientific knowledge, and want to bring with me experts on fish, trees, and birds, that I may be able to learn what the significance of these places be.

Later still, a vice-governor of the islands claimed that "one of the great achievements of this period was [that] within the Philippine government an essentially scientific attitude should have been substituted for the unscientific ways of Spanish days" (Hayden 1942, 644). (W. E. Musgrave [1911, 123], a leading American medical researcher in the Philippines, once claimed that under the Spanish "an attempt to practice and develop the principles of scientific medicine would have led to the starvation of anyone bold enough to undertake such an experiment.") If the Spanish had regarded the archipelago as one great confessional, the Americans hoped to transform it into a vast laboratory.

As early as 1899, the army established a biological laboratory under the direction of Lt. Richard P. Strong, a medical graduate of the Johns Hopkins University and a votary of the new tropical medicine (Anderson 1999b). A few months later the new Board of Health opened a municipal laboratory for Manila. As civil government was organized, Dean C. Worcester, the secretary of the interior in the Philippine Commission, urged the establishment of a Bureau of Government Laboratories that would consolidate all the re-

search activities of the colonial state.[4] In 1901 Paul C. Freer, a professor of chemistry at the University of Michigan, arrived in Manila to direct the bureau; a year later Strong took charge of its biological laboratory (Freer 1902; Cox 1918). The American colonial state had then become actively involved in acclimatizing the laboratory in the tropics. Shortly after, in 1905, the Bureau of Government Laboratories was reorganized and expanded: renamed the Bureau of Science, it encompassed research and service units in tropical medicine, botany, zoology, entomology, chemistry, and geology. The omnibus *Philippine Journal of Science*, first issued from the bureau in 1906, soon became the leading science journal in the tropics. In 1907 the government founded a medical school, which reproduced the Johns Hopkins's emphasis on laboratory instruction, and a new hospital with modern laboratory facilities. The medical school became part of the new University of the Philippines in 1910.

Although the government favored laboratory work, especially if it had an experimental tone, the older descriptive and classificatory projects also received support. The Bureau of Forestry (1900), a successor of the Spanish Inspección General de Montes, and later the Bureau of Science began to rehabilitate Philippine botany (Tucker 1992). Elmer D. Merrill built up the largest herbarium in Asia, with more than 250,000 mounted specimens. He managed exchanges with over eighty institutions and individuals, and he supervised the botanical exploration of the archipelago. At the end of the nineteenth century, botanists had described 2,500 species in the Philippines, and by the 1930s they knew 8,120 species of flowering plants, 1,000 species of ferns, and 3,000 species of algae, lichens, and mosses (Merrill 1936). The Bureau of Mines (1900), which merged in 1905 with the Bureau of Science, demonstrated similar industry in investigating the geological resources of the islands. Albert E. Jenks, based at the Bureau of Ethnology—a special interest of Worcester's—surveyed the "non-Christian tribes" of Luzon and established a museum of local types, which in the 1930s, along with the holdings of the Bureau of Science, was incorporated into the National Museum of the Philippines (Galang 1936).

At the Manila Observatory, renamed the Weather Bureau in 1901, Jesuit scientists continued to make meteorological observations and predictions, and to conduct seismological research. Unlike other scientists in the Philippines during this period, the Jesuits kept apart from the American university and medical networks, preferring to maintain contact principally with

Jesuit observatories in Shanghai, China, and in Havana, Cuba. José Algué, S.J. (1904), the director of the observatory from 1897 to 1925, studied the nature of the typhoon and investigated climatic influences on crop production in the islands; the meteorological department produced the first Philippine weather map in 1907; and the magnetic department concentrated on documenting variations in magnetic declinations. Ironically, the Jesuits in the astronomical department had the responsibility of taking observations of star transits in order to set the correct time in the most modern of colonies (Doucette 1936; Repetti 1948; Schumacher 1965).

However, even as it was getting to know the territory and realize the economic potential of the land, the new colonial government was investing most heavily in biomedical research so that it might get to know more intimately the bodies of Filipinos and displaced Americans. Just as early Spanish science in the Philippines had given priority to a search for medicinal plants that would possibly prove useful to the colonizers, Americans first took care to track down and isolate tropical pathogens that might imperil alien dominance of the archipelago. Newly identified germs were traced over the land, in food and water, and, most dangerously, among insects and native hosts (Anderson 2006). Initially most medical research took place in the biological laboratories of the Bureau of Science, but the locus of investigation soon shifted to the new Philippine General Hospital and the Medical School of the University of the Philippines. Filipino and American physicians organized themselves into professional societies in which members could present research findings and discuss clinical problems. The mestizo elite formed the Colegio Médico-Farmacéutico in 1899. However, the American-dominated Manila Medical Society was established in 1901, and merged into the new Philippine Islands Medical Association (a branch of the American Medical Association) in 1903. From 1908 the government sponsored the Far Eastern Association for Tropical Medicine.[5] The army investigated tropical diseases through a succession of special Boards of Study, in which Weston P. Chamberlain and E. B. Vedder were central figures. Such support for medical research was unparalleled in the colonial world. In 1909 Freer (1909, 72) proudly announced to a new class of Filipino medical students that:

> In Manila we now have a scientific library which gives access to all the recent literature, laboratories which subject the existing diseases to the search light of exact investigation and which give certain diagnosis and accurate statistics, hospitals in which careful studies can

> be carried on, medical associations which bring us into contact with members of the profession in contiguous countries, and a journal by means of which the results of the work accomplished may be placed in the hands of our colleagues throughout the world.

So great were these opportunities, according to Freer (ibid., 73), that a diverse collection of "ambitious and well-trained investigators" had come to the islands to transform the conventional understanding of the tropics. In the Philippines there was "pre-eminently a position for the higher type of educated American investigator, not only for the actual material results which he may obtain, but also for the benefit which will accrue by his very presence in the community" (Freer 1905, 7).

In fact, it proved difficult to attract good American scientists to the Philippines, and to retain the few who did venture to the colony long after arrival. Overwhelmed by service work, scientists found the routine dreary and arduous, and the social life in Manila stultifying. The bacteriological laboratory soon became a factory for diagnosis: in 1909 it made 14,494 microscopic examinations to diagnose gonorrhea, and studied 700 specimens of blood, over 900 urine specimens, and over 7,000 fecal specimens. When cholera broke out in 1914, the laboratory staff had to cope with an influx of over 126,000 fecal specimens (Freer 1910, 16; Cox 1915, 11). Wearied by the climate, isolated from colleagues in the United States, few scientists stayed longer than a couple of years. Still, many of them did find time for useful research. Even routine testing could be reframed as original research, either as an investigation of occult germ carriage or a refinement of bacteriological methods. From "routine" tests, Richard Strong had helped to clarify the distinction between the causes and character of amoebic and bacillary dysentery (Anderson 2006). Physicians at the Bureau of Health and at the hospitals studied the treatment of yaws, beriberi, and leprosy. The Army Board conducted extensive physiological and hematological investigations of American acclimatization in the tropics (ibid.). W. E. Musgrave (1911, 125) recalled that, for a while, "the field was so virgin and the practicable problems, which looked easy of solution to the mind of the investigator, were so numerous that often it was difficult to select that which was most important and easiest of solution." For a number of expatriate scientists, their early Philippine research served as the basis for a successful career back in the United States.[6]

For a few scientists, colonial opportunities for human experimentation nearly ruined their careers. Certainly they cost some Filipinos their lives. In one of the earliest American efforts to use prisoners for medical research, Richard Strong inoculated twenty-four inmates of Bilibid prison with an experimental live cholera vaccine in 1906 (Chernin 1989). Unfortunately, the cholera cultures had become contaminated with plague organisms, and thirteen of the research subjects died. An investigation determined that Strong had conducted the inoculations "in the convalescent ward [where] he ordered all the prisoners to form a line . . . without telling them what he was going to do, nor consulting their wishes in this matter." The investigating committee suggested that Strong had forgotten "the respect due to every human being in not having asked the consent of the persons inoculated" (U.S. National Archives 1907). Strong was reprimanded; he suffered a breakdown; but he later salvaged his career, becoming the first professor of tropical medicine at Harvard.

Before long, it seemed that the laboratory might reshape the lives of Filipinos as effectively as any religious ritual performed during the Spanish era. American and Filipino elites soon accepted that they needed a laboratory to understand health and disease, just as laboratory workers conceded that they were obliged to address issues of local concern in a manner appealing to colonial patrons. But the impact of the laboratory was not limited to the elite. Some ordinary Filipinos came to observe a facile coincidence of laboratory and church in their daily lives. Medical science and religious doctrine at least shared goals and rhetoric, although their methods differed and medical salvation would always be somatic, not spiritual. The laboratory told Filipinos that even apparently healthy or clean compatriots might carry the tropical germs among which they had evolved, especially if they had engaged in unsanitary—or sinful?—habits. As colonial subjects, they were expected to acknowledge their potential for disease carriage—to confess their sins—and accept the laboratory into their lives, allowing it to extract and examine whatever secretions or bodily fluids it deemed necessary. While Christ's blood and flesh might transsubstantiate into wine and wafer, the bodies of Filipinos kept disappearing into germs on agar plates. In order to keep Filipinos pure and free from such sin, the Bureau of Health, relying on the intelligence of the laboratory, exhorted them to reform personal habits and domestic hygiene. The rituals of washing hands, eating with knife and fork, regular and fastidious toilet, careful diet, vigorous exercise, and so on promised to allow

them, in time, to transcend tainted native embodiment and to acquire the fastidious body of the citizen, a body just like the one the Americans thought they possessed (Anderson 2006). The "gospel of hygiene" preached by the Bureau of Health was written in the lexicon of the laboratory. "The distinctive achievement of the American administration in the Philippines," wrote David P. Barrows (1914, 59), a director of education in the islands, "is in the social and spiritual transformation of the Filipinos themselves: the pains taken to make better men." But, as with the church, it is likely that not all those touched by the word of the laboratory in the Philippines were utterly transformed by it.

From the beginning of American occupation, many ilustrados welcomed a more progressive and scientific colonial government, even if it required them to pretend to need further supervision and tutoring. T. H. Pardo de Tavera, for example, was a leading physician and politician who readily moved into the senior ranks of the colonial administration. For pragmatic technocrats like Pardo de Tavera, independence might be delayed indefinitely (Anderson 2006). Others resented the foreign disparagement of Filipino achievement and the persistent preference for European or North American scientists on colonial tour. Many of the frustrated Filipino intelligentsia, previously confined in the lower ranks of the government bureaus, supported the rapid "Filipinization" policy of Francis Burton Harrison, governor-general between 1914 and 1920. However, the Bureau of Science, where most "advanced" work took place, was the last government body to Filipinize; when it did slowly begin to promote Filipino scientists Worcester, Heiser, and Forbes protested to the American authorities, claiming that the civilizing mission had been betrayed. The first generation of American scientists and officials in the Philippines worried that Filipinization policies were premature and would lead to the degeneration, or contamination, of scientific work in the archipelago. They feared that, despite all recent efforts to instill Filipinos with the "spirit of research," the local type remained "a copyist, an imitator [with] no constructive genius or initiative" (Musgrave 1912, 166). Worcester (1914, 685) was convinced that "the Filipinos are where they are today only because they have been pushed into line, and if outside pressures were relaxed they would steadily and rapidly deteriorate." "Shall they," he asked, "be left to stagger along alone, blind in their own conceit?" (ibid., 695). The Spanish had always distrusted mestizo and indio priests; until the 1920s many Americans continued to regard Filipinos as unqualified for science.

Converting to National Science

In 1936 Camilo Osias (1936, 624–25), the president of the National University, observed that "under the new order, there is a special call to men and women of science. More men and women need to be yoked for science." He went on:

> If we as a people are to surmount the difficulties ahead we must apply to our life the ways and methods of science. We need to follow the careful laboratory method of fact finding, the scientific way of conducting research and sifting the facts, and the relentless procedure of science without partisanship or prejudice. (ibid., 625–26)

Despite protests from the old guard, the process of Filipinization continued apace and the achievement in 1935 of Commonwealth status, under the leadership of Manuel L. Quezon, officially signaled the increasing autonomy of the Philippines. In 1903 Filipinos had constituted half the colonial bureaucracy, appointed mostly at lower levels. In 1921 90 percent of the 14,000 public servants were Filipino, and in the 1930s Americans occupied only 1 percent of government posts, mostly at senior levels or in research positions (Agoncillo 1969; Friend 1965). During the 1930s science was conventionally linked to nation building and the earlier American emphasis on its role in a more general civilizing mission seemed redundant and insulting. Leopoldo B. Uichanco (1936, 190), from the University of the Philippines, welcomed "the greater extension of science-consciousness in Filipino life." Others, such as Eulogio B. Rodriguez (1936, 91), the director of the National Library, endorsed this optimism, claiming "the future is bright because our people are becoming scientific-research-minded." But Rodriguez (ibid., 92) echoed older American concerns when he observed "one of the great handicaps of inventors and scientists in tropical countries is a warm climate, which is not conducive to continuous mental effort." More commonly, national self-assertion substituted for such outdated environmentalist pieties. Angel S. Arguelles (1936, 29), the Filipino director of the Bureau of Science, declared "a nation dedicated to science, that applies it in various complex national activities, can look forward with confidence to its future and is bound to survive through the vicissitudes of time." Applied science, he believed, "would evolve a virile and progressive nation" (ibid., 28).

American claims for priority in science became ever less compelling as the United States began to loosen its hold on the archipelago. Rizal had

come to represent a more attractive model and guide than Worcester. For Victor Buencamino (1936, 108), a Cornell-trained veterinarian and the undersecretary of agriculture and commerce in the 1930s, "scientific progress in the Philippines is one of the outstanding achievements of American occupation of the islands," but it was "the product of American-Filipino cooperation," and not simply imposed from abroad. Others continued to give special credit to Americans, especially for the development of medical research. Thus, Antonio G. Sison and Agerico B. M. Sison (1936, 277, 278) admitted, "pioneer Filipino physicians were not duly prepared to master scientific diagnosis" and the "scientific teaching of medicine was started only at the time of the American occupation." Increasingly, though, Filipino scientists regarded Americans as supervening upon an older scientific tradition. At the Bureau of Science, Arguelles (1935, 32) recognized Spain as "one of the torch bearers of Western civilization." "The Spanish regime in the Islands," he wrote, "served as a splendid foundation for a national structure conceived and developed along modern lines" (Arguelles 1936, 17). Americans may have accelerated the development of science in the Philippines, but they did not begin it.

By the late 1920s Filipino scientists dominated the Bureau of Science. Arguelles and his colleagues emphasized the nexus of economic progress and scientific research, promoting studies of ceramics, insecticides, vegetable oils, sugar production, leather tanning, quinine extraction, and forestry and soil surveys. The Bureau of Science continued its service functions, testing foods, examining pathology specimens, manufacturing vaccines and sera, and producing *tiki-tiki* extract from rice husks as a treatment of beriberi. The scientific library at the Bureau had swelled to more than 160,000 volumes and it attracted researchers from China, Japan, Malaya, and the Dutch East Indies (Arguelles 1935). William H. Boynton at the Bureau of Agriculture developed a vaccine against rinderpest, a devastating introduced bovine disease, but it took Filipino veterinarians M. M. Robles and J. D. Generoso to adapt the vaccine so it was practicable in the field. At the Bureau of Health a number of committees were established in the 1920s to study the more common diseases of the archipelago, and Filipino scientists dominated these too.[7] Conversely, the transfer of the Philippines to the Maryland-New York province of the Society of Jesus in 1921 meant that more Americans began to do research at the Manila Observatory during this period. Fr. Charles Deppermann, S.J., conducted major studies of the genesis and paths of typhoons

and his colleagues continued their astronomical and seismic research (Hennessy 1957).

The government still preferred to sponsor scientific research directly through the bureaucracy, not through the universities. Some original investigation did take place at the University of the Philippines, but academics complained bitterly of heavy teaching loads and inadequate grants for research. Senior professors frequently were lured to the United States before they could train suitable successors. In the Medical School scientists performed useful investigations of the causation and treatment of leprosy, typhoid, dysentery, and beriberi; the relations of nutrition and growth; the effect of radiotherapy on malignant growths; and the pharmacology of local medicinal plants (Salcedo 1957). At private universities scientific research received very little support, except at Santo Tomás, where some studies of bacteriology and clinical medicine occurred. In 1932 G. Singian (1932, 372) reported "a new spirit of research and scientific investigation" on the wards of the San Juan de Dios Hospital, where the Santo Tomás students trained, yet the new spirit was but weakly manifest in later years.

Between 1922 and 1935 the Rockefeller Foundation was a major sponsor of scientific and public health projects in the Philippines. Victor Heiser, the director for the East of the International Health Board, guided Rockefeller involvement in the islands. Still decrying the Filipinization policy that had ousted him, the former Philippine director of health used the foundation to reassert control over local scientific and health activities. In the 1920s Heiser sent out emissaries to conduct hookworm and malaria research, supervise medical education, and support the establishment of a School of Hygiene and Public Health (1927). Rockefeller scientists in the Philippines frequently contrasted their "original" investigations with the imitative routine work of Filipinos; among their colleagues they spread the gospel of efficiency and basic research; and they circulated within the foundation extensive reports on the local institutional and political conditions that seemed to impede their investigations (Anderson 2006). Dr. W. S. Carter, the Rockefeller man at the University of the Philippines Medical School, in 1923 complained that he did "not understand, as yet, the oriental mind or the ways of the Dominicans. It is discouraging to try to do something for people who will not do anything for themselves and I am free to say that the inertia of these people passeth all understanding" (Rockefeller Archive Center 1923).

The homology of the Rockefeller and the earlier Jesuit scientific networks is striking: both combined a commitment to transcendent basic research with practical engagement; both developed complex mechanisms of long-distance communication; and neither could avoid accusations of political intrigue. Rockefeller scientists in the Philippines came to occupy the organizational and apostolic niches that the Jesuits had largely vacated. Science might represent a common path to salvation and civilization. "If a large research institution, free from politics, and under pure science control, could be developed in Manila," Heiser (1926) argued, "it would not only be a great aid to the Philippines, but it would also serve as a light house for that part of the world."

By the 1930s most leading political figures agreed that there was a pressing need to reorganize the support of science in the Philippines and to generate work in less applied fields of research. For many years the Philippine Islands Medical Association and the Colegio Médico-Farmacéutico had urged the creation of a medical research council. During the 1930s other scientists joined them in suggesting the establishment of a more eclectic body to investigate a broader range of technical problems. In 1933, at the second Philippine Science Convention, Quezon endorsed a proposal for a National Research Council, which would resemble those in the United States, Japan, and Australia. The council would improve the organization of science, support special research projects, train talented personnel, and enhance relations with foreign scientists. "We feel the time has come," Quezon declared, "for the government to utilize to full advantage our scientific men and women, make them come out of their shell, so to speak, and advise us on matters pertaining to their respective fields" (quoted in Valenzuela 1936, 36). Indeed, the constitution of the Philippine Commonwealth, written in 1934, provided that "the State shall promote scientific research and invention," an extraordinary national commitment to science, at least on the level of rhetoric.[8] But continuing economic stringency meant that support for science did not increase significantly in the 1930s.

In 1941 the Japanese invasion caused the disintegration of Philippine research and educational activities, and the destruction, yet again, of scientific collections and libraries. After the Japanese were forced out in 1945, Filipinos had to rebuild local institutions of science, often from the ground up (McCoy 1980; Steinberg 1967). The Manila Observatory, for example, was utterly destroyed during the Japanese retreat, and its library, including

unpublished manuscripts, perished in the flames. As the new Republic of the Philippines, founded in 1946, set up its own Weather Bureau, the Jesuit scientists after their release from internment planned a new observatory that would leave aside meteorological work and concentrate on seismological and ionospheric research. By 1952 the new observatory was recording earth tremors and bouncing high frequency waves off the ionosphere, and in 1957 it began a program in solar physics, focusing on the study of sunspots. While the old observatory was devoted to the investigation of the earth and its atmosphere, the revived institution extended basic geophysical studies to include the sun (Depperman 1953; Hennessey 1955). As Fr. John N. Schumacher, S.J. (1965, 286), put it, "these Jesuit scientists work to further man's knowledge and mastery of the physical universe, so that it too may enter into the consumption of Christ's Redemption by man's mind and hands."

More typically, postwar Philippine science was justified in secular and economic terms. "Scientific research," according to Miguel Ma. Varela (1954, 366), "does pay off in terms of pesos and centavos, in terms of higher efficiency and reduced man-hours of work, in terms of richer harvests and healthier citizens." Support for science was "part of our contribution for the blessing we enjoy of Filipino citizenship" (ibid., 363). In the 1950s such civic enthusiasm allowed the Philippines to publish twice as many scientific and technical journals, including the *Philippine Journal of Science*, as any other Southeast Asian country (UNESCO 1953). In addition, an Institute of Science and Technology was performing many of the functions of the old Bureau of Science. The National Research Council continued to guide science policy, and universities began to assert the value of original investigation (Quisumbing 1957; Velasco and Baens-Arcega 1984). The Philippine Association for the Advancement of Science was organized in 1951. In 1956 the government created a National Science Board to provide support for research projects, but the Science Act of 1958 replaced this with a more powerful National Science Development Board.

Financial limitations meant that most investigation was still closely tied to local, practical concerns. A Bureau of Soils Conservation, created in 1951, investigated fertilizers and soil capabilities. The Philippine Sugar Institute tried to improve sugar production, while the Philippine Tobacco Administration studied the tobacco industry. Postwar scientists screened the Philippine flora in search of antibiotics and other useful drugs. Their nutritional studies pointed to deficiencies in Philippine diet; they sought the cause of

kadang-kadang, a coconut disease; and they resumed the study of agricultural, marine, and forest resources. At the new Philippine Atomic Energy Commission, scientists investigated shielding against gamma rays and the use of radioactive iodine in treating thyroid disorders (Valenzuela 1960). The state provided virtually all research funding, while private industry, largely foreign owned, did virtually nothing.

In general, research in the Philippines was starved of funds. It was always a struggle to attract promising students to poorly paid careers in science and many of the best investigators who received fellowships to study or work in the United States never returned. From the beginning of the American period, a few students, called *pensionados*, had been awarded government scholarships to study in the United States. In the 1920s and 1930s many more received Rockefeller Foundation fellowships, and after the Second World War hundreds of scientists trained in the Philippines were exported abroad.[9] The prospects at home remained dim. In 1956 a senate committee had reported that scientific work on the Philippines was badly coordinated; research was poorly funded; science teachers were scarce; and science was not a popular topic (Senate Committee on Scientific Advancement 1956). For many the deficiency in scientific research represented a failure of the nation. Gode B. Calleja (1987, 118–19), an expatriate biologist, asserted that "Philippine science is in a very wretched state," despite a high literacy rate and a large enrolment in higher education. By 1977 Hong Kong, Thailand, Malaysia, and Singapore had each surpassed the Philippines in the production of scientific papers. The three Philippine journals covered by *Current Contents* received a total of six citations that year, and most of the feeble efforts at science were in applied biology, not physics or any "abstract" field. The *Philippine Journal of Science* had become, in Calleja's words, "an embarrassment" (ibid., 140). The only decent research laboratories were at the International Rice Research Institute, established by the Ford and Rockefeller Foundations in 1960 at Los Baños—elsewhere "the autoclave represents the most sophisticated gadgetry" (ibid., 141). According to Calleja (ibid., 145), "the failure in science is just a symptom of a far more serious wrong," an index of political failure: he felt that the dictatorial presidency of Ferdinand Marcos was stifling any critical inquiry, regardless of the régime's supportive rhetoric or funding for technocratic solutions. Not until a responsible citizenship emerged in the Philippines would research thrive. While Calleja drew an exaggerated

picture of the demise of Philippine research, his remarks also reflected a widespread belief that science now was as closely linked to citizenship as it had once been to salvation and civilization (Pertierra 2003)

Conclusion

The "specter of comparisons," to use Rizal's haunting phrase, can exert an irresistible attraction but in so doing it draws attention away from important local meanings and contingencies. For three hundred years religious orders wondered if the Philippines was "saved" in comparison with other parts of the world. During the past century or more, American colonialists and Filipino nationalists have attempted to assay, to slightly different ends, the progress of science in the Philippines relative to other nations. To understand why so much time and energy has been expended on apparently futile and specious comparison, one must reflect for a moment on the local significance of "doing science" or "becoming scientific."

It should be evident by now that science has had many different meanings in the Philippines. For some it was a way to observe bodies and territories; for others it suggested an experimentalism that licensed intervention and transformation. Knowledge of the natural world might lead to salvation; or it might make things grow; or it could help to put goods together; or it might prevent or treat disease; or it could seem a worthwhile goal in itself. For the Jesuits scientific research was subordinated to confession building and to achieving personal salvation; for many Americans in the archipelago scientific ability indicated the level of civilization, and whether there was any need of further training; for Filipino nationalists, scientific achievement was intimately linked to national development. In the twentieth century, the laboratory functioned as both index and generator of civic responsibility. The more laboratory-like, or scientifically-minded, the Philippines became, the more elevated in civilization Filipinos might appear to Americans and the more modern and responsible Filipinos might appear to themselves. Conversely, Americans, in detecting a failure in local science, often affirmed a continuing need for colonial supervision and training, while Filipinos might regard the same alleged deficiency as a sign of political neglect or imperial exploitation, suggesting a need for more, not less, national self-assertion. By the end of the twentieth century, then, science in the Philippines had become a sort of civic conscience, nagging away at the nation-state.

Notes

For comments on earlier versions of this essay I am grateful to Dan Doeppers, Ronald Numbers, Vince Rafael, Gabriela Soto Laveaga, and two anonymous reviewers. Judy Kaplan provided valuable research assistance.

1 Under the Spanish regime, mestizo meant a person of mixed Spanish-local ancestry or mixed Chinese-local ancestry; ***peninsulares*** were Spaniards from Spain; criollos were persons of Spanish ancestry born in the Philippines; and ***indios*** were descendants of the original inhabitants.

2 Le Gentil (1964, 74) claimed that "all the ancient prejudices of the schools would appear to have been abandoned in Europe only to take refuge in Manila, where they will probably survive for a long time; for the ancient doctrine is too well supported there to be displaced by the sane doctrine of physics. Don Feliciano Marquez has often told me frankly that Spain is a hundred years behind France in science, and that Manila is a hundred years behind Spain."

3 The work of the Jesuits in the Philippines casts doubt on Ashworth's (1986, 160) claim that, by the end of the seventeenth century, Jesuit science was "irretrievably isolated from the main currents of the scientific revolution."

4 Worcester, a graduate of the University of Michigan, was a keen zoologist and ethnologist who had visited the Philippines on scientific expeditions in the Spanish period. He dominated the colonial government until his retirement in 1913, protesting against the increasing trust in Filipino expertise. When he returned to the islands in 1915 he developed a successful business career, while doing some ornithology and archaeology on the side. See Worcester 1898, 1914; Sullivan 1991; Stanley 1984. Sullivan (1991, 4) writes that Worcester "was ambitious, tireless, 'scientific,' unscrupulous in pursuit of what he considered right, and ruthless in riding over those who opposed him. . . . Notably self-righteous, he was vehemently critical of Filipino society, its values, and its traditions, yet America and its institutions he held sacred." Paul C. Freer was Worcester's brother-in-law.

5 The Manila Medical Society published a quarterly bulletin from 1909; and the *Journal of the Philippine Islands Medical Association* began in 1921 (Fernando 1953). Other scientific journals founded in the early twentieth century include *Revista Filipina de Medicina y Farmacia*, *Philippine Agriculturalist*, *Philippine Journal of Agriculture*, and the *University of the Philippines Natural and Applied Science Bulletin*.

6 For example, Gilbert N. Lewis, a chemist, later led the chemical service of the U.S. expeditionary forces in the First World War; Warren D. Smith, the chief of the Bureau of Mines, became head of geology at Oregon State; Jenks went on to the chair of anthropology at Minnesota; H. N. Whitford, a botanist at the Bureau of Forestry, became professor of tropical forestry at Yale; W. J. Calvert, a bacteriologist, became professor of medicine at Missouri; J. W. Jobling, the head of the serum laboratories, became director of the Morris Research Laboratories in Chicago; W. B. Wherry and Paul G. Woolley of the Bureau of Government Laboratories became professors of pathology and of bacteriology, respectively, at the University of Ohio; Maximilian Herzog was appointed professor of pathology at Northwestern; H. T. Marshall became professor of pathology at the University of Virginia; and Musgrave later taught at the University of California at San Francisco.

7 The committees included infant mortality (1912–1914); typhoid fever (1916–1922, 1922–1925); leprosy (1927); malaria control (1926–1936); beriberi (1923–1925, 1926); and mental hygiene (1932–1933). See Lopez Rizal 1936.

8 Article XIII, section 4. See Hayden 1942, 543.

9 At least 5,500 Filipino professionals, especially physicians, went to the United States to live between 1952 and 1966. See Bello 1969 and UNESCO 1970.

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