Scientific Representations at the UPR School of Tropical Medicine. IV: Special Technical Studies

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The essay examines the scientific representations that unfolded and evolved at the University of Puerto Rico School of Tropical Medicine (STM) under the auspices of Columbia University (1926-1949). This article on the STM's scientific endeavors is the fourth in a historical serial collection about the images and evolution of sciences at the institution and it portrays the diagrammatic representations of special technical research aspects and studies (i.e., personnel, epidemiology, methodology, animal studies, biology, field studies, treatment and immunology, and chemotherapy agents). The essay focuses on the emerged scientific representations and on the nature and evolution of sciences at the School, and has been divided into four sections: a) images of science, b) evolution during the first two eras, c) the third and last era unfolding, and d) special technical studies. In this paper the scientific representations have been brought about mainly through the analyses of research publications in external and local venues. The analysis of the STM's scientific evolution has been organized in three distinct historical stages: 1926-31, 1932-40, and 1941-49. These representations open an exploration pathway for a better understanding of the intricate interrelationships between the techné and the episteme horizons of tropical medical science in Puerto Rico. [*P R Health Sci J 2020;39:178-183*]

Key words: Tropical medicine history, Science history, Techné and episteme

This article is the last part of an essay in a historical series about the University of Puerto Rico (UPR) School of Tropical Medicine (STM) under the auspices of Columbia University. The general purpose of the essay is to elucidate the kind of sciences that prevails at different moments and the nature of their epistemological contribution. This serial collection article uses the approach of diagrammatic representations on the research personnel and on the following special technical studies and publications by the STM's faculty: epidemiology, methodology (i.e., laboratory methods, apparatus, and clinical techniques), animal models, biology (i.e., life cycle, special sciences, species and strains), field studies, therapies and immunology, and chemotherapy agents.

These particular diagrammatic representations open an additional pathway for a better understanding of the intricate interrelationships between the techné and the episteme horizons of tropical medical science through a systematic elaboration of research and scientific categories organized by historical periods: 1926-31, 1932-40, and 1941-49. It also generates confirmatory or unexpected images about the written historical narratives previously elaborated in the serial collection. In a sense, this article is driven by the expectation that the methodological and technical sketches which have been diagrammatically outlined here would offer new historical insights on tropical medicine research. Nevertheless, it should be clear that the ocular directedness of this methodological pathway are constructed representations constrained by analytic reductions, statistical summaries, and theoretical synthesis, where views and perspectives are delineated for the reader through the diagrams, while allowing for their own interpretations. These diagrammatic representations include relevant information to motivate further studies on the history of science and tropical medicine in Puerto Rico. The main historical source of the data in the tables are the STM's published special technical studies, and the most important scientific images revolve around the horizons of techné (in the sense of skills and technical crafts) as another way of achieving epistemic scientific understanding.

Diagrams

This section presents the series of eight diagrams (i.e., tables) on the STM's technical and methodological aspects and studies, and their respective discussions.

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Table 1. Research Assistants (A) and Technicians (T) by Eras: 1926-31, 1932-40, 1941-49*

Discipline	First Era (3 y.)		Second Era (4 y.)		Third Era (3 y.)		Individuals	
	A	T	A	T	A	T	A	T
Chemistry	1	-	3	1	5	-	9	1
Dermatology	1	-	-	3	2	-	3	3
Bacteriology	-	2	2	3	3	-	5	5
Parasitology	1	-	-	3	4	-	5	3
Pathology	-	1	-	4	2	-	2	5
Clinical Med	-	-	-	-	5	1 (X Rays)	5	1
Others	Librarian		Librarian		Librarian, Dietitian		(4)	
Totals (A, T)	3	3	5	14	21	1	29	18

*Sources: a) UPR Institutional Archives, Río Piedras Campus, STM List of Salaries, 1926-27; and b) Archives and Special Collections, A.C. Long Health Sciences Library of Columbia University, Announcements (available): [1927-28, 1929-30] [1931-32, 1934-35, 1935-36, 1936-37] [1941-42, 1944-45, 1945-46]. Statistics by single individuals (non-repeated within an era).

The academic and personnel status of research assistants were definitely higher than technicians. During the first year, the School had three research assistants: one in Mycology, a doctoral candidate from the UPR, one in Parasitology with a bachelor in science from Harvard, and one in Chemistry with a bachelor in arts from Columbia. All of them were included in the faculty roster and were mentioned as authors or co-authors in several faculty publications; two became instructors in the second era. In general, technicians were considered as scientific skilled personnel and received lower salaries than research assistants (half or lower amounts); in some cases, having a higher education was not even a requirement. However, technicians also benefited from the School's institutional policy of academic incentives for assistants, technicians and graduate students, and a few of them became first rate scientists.

Table 1, on research assistants and technicians, evokes the following images which require some comments. First, during the initial era (1926-31), the number of assistants and technicians were balanced, and the three research assistants were placed under the two Columbia University professors (D.H. Cook in chemistry and W.A. Hoffman in parasitology) and with B.K. Ashford in mycology; and second, technicians worked for the two kinds of laboratory medical fields (bacteriology and pathology). In the second era (1932-40), the most important finding was the relevant incremental techné and predominance of technicians over research assistants. Also, chemistry increased its research assistants while bacteriology integrated the rest by changing its research laboratory facet, and laboratory work in dermatology and parasitology apparently became delineated by the technical dimension. The third and last scientific era (1941-49) displays signs of the occurrence of a significant transformation in which the position of technician disappeared from the research scenario: technicians became research assistants, and some assistants and technicians were reclassified as faculty instructors. It is possible that this research schema transformation could be related to the contextual change in the School's directorship, which suggests that this improvement in the academic position of local personnel was at least a posteriorly interconnected event-as it was discussed in the previous article of this serial collection ('The Evolution of Science, the Last Era').

The unexpected significant transformations of research and technical personnel during the last two eras were the incremental techné and predominance of laboratory technicians over research assistants in the second epoch and the reversal change in the last era, in which the position of technicians almost disappeared and some research assistants and technicians became instructors. These diagrammatic images also confirmed the control of chemistry over the positions of research assistants throughout the lifetime of the School.

Table 2. Epidemiological Studies by Historical Eras*

Period	Epidemiology & Outbreaks	Surveys & Studies of...	Clinical studies or Autopsies	
I. 1926-31	Diarrhea/Enteritis (3) Others with 1 (TB, Lepra, Syphilis, Food infection)	Brucella abortus (2), Rat fleas (2) Others with 1 (Filaria, Lepra, Dysentery, Strep, Infant mortality, Diabetes)	Blood pressure (2), Others with 1 (TB, Neoplasms, Schistosomiasis)	
Subtotals	7	10	5	(n=22)
II. 1932-40	Schistosomiasis (7), Influenza (2) Hookworm (1)	TB (6), Filariasis (3), Food poison (2), Parasites (2), Syphilis (2), Others with 1 (Dysentery, Hematological, Brucella, Strep)	TB (2), Sprue (2), Others with 1 (Syphilis, Filaria, Malaria, Sudden death)	
Subtotals	10	19	8	(n=37)
III. 1941-49	Salmonellosis (3) Nutrition Problems (3), Brucella (2), Typhus (2), Others with 1 (Syphilis, Schistosomiasis, Malaria, Hookworm)	Filaria (2), Heart dis. (2) Others with 1 (Strep, Shigellosis, Infant mortality)	Sprue (2), Hemat. (2) Others with 1 (Filaria, Leptospirosis, Venereal L. granuloma)	
Subtotals	14	7	7	(n=28)

*Sources: a) STM of the UPR under the auspices of Columbia University, Collected Papers (1926-1938), Biblioteca Nacional de Puerto Rico, Instituto de Cultura Puertorriqueña; and b) Archives and Special Collections, A.C. Long Health Sciences Library of Columbia University, Dean's and Director's Reports (1930-1948), and E. Koppisch, Interim Director, Last Report, June 30, 1949. Statistics by frequency of subjects. Highest frequencies of health conditions in all categories and eras: TB (10), Schistosomiasis (8), Filariasis (8), Dysentery (5), Syphilis (5), Brucellosis (5), and Sprue (4).

The epidemiological representations presented in Table 2 show that tuberculosis was the most frequent health condition subject of epidemiological studies at the STM, probably associated to its high prevalence, widely social and spatial distribution, and stigmatized endemic morbid state. Interestingly, although dysentery was not a principal scientific focus of research at the School, its sporadic and diverse symptomatic nature favored it being a subject of interest for public health episodic and periodical studies. Expectedly, these epidemiological representations confirmed the importance of schistosomiasis and filariasis as the STM's scientific paradigmatic diseases.

Table 3. Methodological Studies by Historical Eras*

Categories	1926-31	1932-40	1941-49	Totals
Laboratory Methods & Techniques	3	11	18	32
Surgical and Clinical Techniques	1	3	9	13
Apparatus	-	4	2	6
Totals	4	18	29	51

*Sources: See Table 2. Statistics by frequency of types of studies.

As seen in Table 3, methodological studies depicted an expected upsurge in laboratory methods and techniques studies and publications during the last two STM scientific eras. It is correlative evidence of the significant and relevant manifestations of scientific research in tropical medicine at the time. The increment in surgical and clinical technical studies in the last era accompanied the development of clinical medicine research during this period. Apparatus innovations were mainly a creative aspect of the chemistry disciplinary field at the School.

Table 4 shows that in terms of animal models and studies, although rodents as a group were the research animals most frequently used, primates were the most important individual research animal at the School-a finding which could be expected because of the existence of the primate colonies at Cayo Santiago under the administration of the School. Interestingly, mice were the main research animal models in the last era.

Table 5 illustrates that life-cycle research of organisms were significantly more frequent in biological studies at the School, which is a testimony

Table 4. Animal Studies by Historical Eras*

Period	Experimental animals	Animal health/Vet med.	Totals
I. 1926-31	Monkey (2) Human (1) (n=3)	Monkey (1), Canine (1), Chick (1), (n=3)	6
II. 1932-40	Rat (3), Hog (2), Monkey (2) Guinea pig (1), Cattle (1) (n=9)	Mouse (2) Others with 1 (Monkey, Rat, Hog, Cattle, Frog) (n=7)	16
III. 1941-49	Mouse (5), Guinea pig (3), Cattle (3), Rat (2), Mice (2), Chick (2), Monkey (1), Rabbit (1) (n=19)	Monkey (3), Rat (3), Mouse (1), Hen (1) (n=8)	27

*Sources: See Table 2. Statistics by frequency of animals. Highest frequencies of animals in all categories and eras: Rodents (rat, mouse, mice, guinea pig) (16), Monkeys (10), and Cattles (5).

of both an interest in the integral or comprehensive study of parasitic forms and of the highly developed state of tropical medical science in the Island. On studies of the identification of species and strains, fungi was the main organism target during the first two scientific epochs with the well known contribution of mycotic science, but, at the end, parasitology zoological interests became predominant.

The relatively low frequency of field studies (see Table 6) could be considered a surprise finding, but it must be noted that the source of the data are published studies. Field studies were

Table 5. Biological Studies by Historical Eras*

Period	Life-cycle studies of organisms	Biological sciences studies (e.g., entomology, botany, zoology)	Species/Strains studies	
I. 1926-31	Fasciola hepática (1) E. histolytica (1)	Aedes aegipti (1), Fungi (1), Helminth (1)	Fungi	
Subtotals	2	3	6	(n=11)
II. 1932-40	Schistosoma (5) Uncinaria (1)	Viruses (3), Monkey (2), Culicoides (2), Strep (2), Others with 1 (Anopheles, E. histolytica, Termites, Latex ficus)	Fungi (4) Trematoda (2) E. histolytica (1) Gum prod. org. (1)	
Subtotals	6	13	8	(n=27)
III. 1941-49	Shigella (8), Schistosoma (6), T. bragai (2), Others with 1 (P. fastosomun, S. typhosa, Isosphora hominis, Bufo marinus)	Mites (5), Culicoides (4), Fleas (2), Others with 1 (Anopheles, Sand fly, Ants)	Others with 1 (S. paradysentariae, Borinquolaelaps, Hoffmania, Ornithodorus, a Bromelia protease, & a Listeria strain)	
Subtotals	20	14	6	(n=40)

*Sources: See Table 2. Statistics by frequency of organisms or subjects.

done mostly in association with the health department, and their goals were particularly related to health control interventions. Thus, instead of studies geared toward scientific knowledge and publication, their motivations were eminently sanitary, and their research practices were applied and instrumental. The highest frequency of control techniques in the last era is a reflection of those hygiene goals.

As shown in Table 7, in the area of treatment and immunologic studies the schistosomiasis and filariasis abundance was an expected image since they are considered paradigmatic sciences at the STM. The high presence of sprue among treatment investigations could be considered a kind of confirmatory episteme, due to its renewed research interest in the last STM scientific epoch.

Finally, focusing on medical drug therapies at the time (see Table 8), excluding surgical treatments and medicinal plants studies, the following findings merit to be mentioned: a) the STM was not ready to carry on these kinds of research studies during the first era; b) there was some interest in testing sulfa drugs in the first epoch; c) schistosomiasis and filariasis were the most important focus among health conditions for chemotherapy investigations; d) antimonials were first choice for treating schistosomiasis disease, and some of them even were tested to treat other conditions; e) specifically, antimonial Fuadin for schistosomiasis and diethylcarbamazine Hetrazan for filariasis were considered primary or secondary drug choices; f) vitamins were the principal subjects of interest in sprue treatment; and g) in the last era, there was an upsurge of research interest in diverse health conditions and medical treatments, which is another reflection of the clinical medicine scientific development at the School. The diagrammatic representations of medical drug therapies research and publications during the last epoch foretell the dawn of a new medical era: the treatment of antimonial intoxications and the incoming presence of penicillin and antithyroid drug studies as part of a growing research development of the disciplinary area of clinical medicine.

Table 6. Field Studies and Health Control Techniques by Historical Eras*

Categories	1926-31	1932-40	1941-49	Totals
Expeditions	1	1	1	3
Control field studies	-	2	1	3
Control techniques	-	2	5	7
Totals	1	5	7	13

*Sources: See Table 2. Statistics by frequency of types of studies.

Table 7. Treatment and Immunological Studies by Historical Eras*

Period	Treatment Studies of health conditions	Immunology Studies Serological Tests (T, PT), Skin reactions (Rx) or Immunology (antigen, antibody) (Imm.)	Totals
I. 1926-31	Filariasis	Schistosomiasis (PT=precipitin test) Fasciola hepática (PT) Schistosoma mansoni (Rx) Wuchereria bancrofti (Rx) Hypersensitivity hookworm (Imm.)	
Subtotals	1	5	6
II. 1932-40	Filariasis Schistosomiasis Lymphangitis (2) Parasitic anemia Anemias (2) Linfogranuloma venereum Welchii infection	Necator americanus (Rx) Hookworm (Rx) Imm. Resp. Rec Lymphangitis (Imm.) Pure protein antigen Brucella (Imm.) Imm. serum Trichinella (Imm.)	
Subtotals	9	5	14
III. 1941-49	Filariasis (6) Schistosomiasis (7) Sprue (8) Taenia saginata (2) Influenza (2) Dysentery (2) Others with 1 (Ascariasis, Trichinosis, Amebiasis, Typhus, L. venereum, Endocarditis, Hypertension, Hyperthyroidism, insect bites, Antinomial intoxication) (10)	Tuberculosis (Rhesus) (T) Salmonella (PT) L. venereum (Frei Test) Schistosomiasis (Slide Test) Schistosoma mansoni (Rx) (2) Filariasis (Rx) Filariasis (Imm.) Ascaris (Isoagglutinogen) (Imm.) (5) Trichinella spiralis (Imm.) (2) Bacillary dysentery immunity (Imm.)	
Subtotals	37	16	53
Totals	47	26	73

*Sources: See Table 2. Statistics by frequency of types of studies. Highest frequencies of health conditions in all categories and eras: Filariasis (12), Schistosomiasis (12), Sprue (8), and Ascariasis (5).

Postscript

This Special Technical Studies' paper provides a visual summary of various evolutionary tracts at the School, from basic and fundamental research to clinical, therapeutic, methodological and administrative developments. The Institution continued refocusing its areas of research as new methods or theories and newly trained personnel became available, as well as the disposition of local and international institutions to collaborate and participate in such efforts increased. This was in keeping with a prevalent agenda aligning aforementioned resources to the epidemiologic realities surrounding it.

It is clear that the Institution kept abreast of the times, while it explored the developing medical environment to address local situations, even if this meant distancing itself from what have been the traditional subject-matters of tropical medicine. The focus and attention on parasitic diseases prevailed during the lifetime of the School, particularly in filariasis and schistosomiasis, diseases which together with malaria had been brought into control or eradicated as the School neared its end. The looming reality of metabolic and non-transmissible diseases, and the local postwar need for physicians, foreshadowed the need for a significantly reorganized institution or the substitution by one better suited to address them.

This historical series on the School of Tropical Medicine demonstrates how a specialized school employs its assets during periods of heightened uncertainties. When the School closes operations it leaves a legacy and provides a foundation that is readily adopted by a succeeding institution. However the growth and focus on tropical medicine as a discipline abruptly declined. These scientific narratives reminds us that the advent of a new era when tropical diseases will expand their geographical scope as a result of anthropogenic global warming will require a refocusing into this field of research and health care. In this sense, much has also been lost in this story of tropical oblivion.

Table 8. Treatment Studies: Health Conditions and Chemotherapy Agents by Historical Eras

Period	Health Conditions		Agents
I. 1926-31	Filariasis	←	Sulpharsphenamine (subcutaneous) (arsenic compound)
II. 1932-40	Filariasis	←	Gentian violet
	Schistosomiasis	←	[1]Fuadin (trivalent antimony) [1-2]Tartar emetic (potassium antimony)
	Parasitic anemia	←	Iron salts (ferrous sulfate)
	Linfogranuloma venereum	←	[3]Sulfanilamide (sulfur compound)
	Welchii infection	←	[3]Sulfanilamide
III. 1941-49	Filariasis	←	[3]Adrenalin (hormone-early febrile stage) [1-2]Hetrazan (diethylcarbamazine) [3]Neostibosan (pentavalent antimonial)
	Schistosomiasis	←	[2]Anthiomaline (lithium antimony) [1]Fuadin (Stibophen) Gentian violet Neostibosan (pentavalent antimonial) Urea stibamine (pentavalent antimonial)
	Sprue	←	[3]Folic acid (a B9 vitamin) Histamine (organic nitrogenous) [3]Pteroylglutaminic acid (folic acid) [3]Vitamin B12
	Ascaris	←	[3]Diethylcarbamyl chloride
	Taenia saginata	←	[1]Atabrine (quinacrine)
	Endemic typhus	←	[3]Atabrine
	Bacillary dysentery	←	[3]Sulfaguanidine (a sulfanilamide)
	Insect bites	←	Chloroform
	Subacute bacteria endocarditis	←	[1]Penicillin
	Hyperthyroidism		[1]Thiouracil (an antithyroid drug)
	Antimonial intoxication	←	[3]BAL (dimercaprol)
	Influenza	←	BAL
	Leprosy	←	Sulfanilamide
	Hypertension	←	[3]Potassium thiocyanate

*Sources: See Table 2. Drug choices, at the time: [1]primary choice, [2]secondary choice, [3]useful for some purpose or at some stage. Choices are based on the references listed at the end of the article.

Figures 1. "Section of a laboratory showing the methods of measurement of ultra violet radiation" (Report of the Director 1938). Open Access digitized source: Archives and Special Collections at the Augustus C. Long Health Sciences Library of Columbia University, School of Tropical Medicine under the Auspices of Columbia University, Annual Reports of the Director.

Resumen

Este ensayo examina las representaciones científicas que emanan de la historia de las ciencias que se establecen y evolucionan en la Escuela de Medicina Tropical (EMT) de la Universidad de Puerto Rico bajo los auspicios de Columbia University (1926-1949). Este es el cuarto artículo de una serie histórica sobre las imágenes científicas y la evolución de las ciencias en la institución, y explora las representaciones diagramáticas que emergen principalmente de los estudios técnicos y metodológicos publicados (i.e., asistentes de investigación y personal técnico, epidemiología, metodología, estudios de animales, ciencias biológicas, estudios de campo, tratamientos e inmunología, y agentes quimioterapéuticos). Los resultados generales del estudio se presentan en una serie de cuatro artículos: a) las imágenes de la ciencia, b) la evolución de la ciencia en las primeras dos etapas (1926-31 y 1932-40), c) el desarrollo en la tercera y última etapa (1941-49), y d) los estudios técnicos especiales. Este articulo serial tiene como propósito que las representaciones diagramáticas construidas ayuden a elucidar la interrelación entre los horizontes de la techné y la episteme de la historia de las ciencias de la salud y de la medicina tropical en Puerto Rico.

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