"The development of Plant Pathology in Peru: historical review"

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Opening remarks

This paper presents the historical background of the beginnings of Plant Pathology in Peru that the author has been able to obtain on the basis of a literature review, information exchange with seniors colleagues, or remembering facts himself; any omission is involuntary and I apologize for that. The facts and contribution of the new generation of plant pathologists belong to recent history and correspond to them to continue with its diffusion.

The development of this science has changed significantly since the foundation of the Escuela Nacional de Agricultura y Veterinaria de Santa Beatriz, Lima (National School of Agriculture and Veterinary at Santa Beatriz, Lima) to date. At the beginning had European (Belgian) and North American influence; many Peruvian plant pathologists have obtained their academic degrees in the United States of America and Europe universities. The new generations of plant pathologists in Peru have better tools and

better information to perform in their teaching, research and extension duties. The taxonomic redefinition of some genera of fungi such as *Blumeria*, *Marsonia*, bacteria such as *Ralstonia*, etc., the relocation of fungi of the Class Oomycetes to the Kingdom Chromista, Class Oomycota, related to algae, the epidemiological studies, complemented with population genetics of pathogens, permit now a full understanding of the development of many diseases, its prediction and the concept of economic damage threshold, over which value yields will be affected. All these skills allow the rational use of control tactics as a means of implementing the strategy of Integrated Plant Disease Management.

109 years have elapsed since the beginning of plant pathology in this country; from now on, there is no more than invoke the generation of young pathologists to keep working to achieve their goals, and to my senior colleagues to support them. It is always necessary to take into account our history, because in it lies the future of this discipline.

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Plant Pathology in Peru: its beginning, institutions and individuals who have contributed to it

Germán García Rada (13), in his book “Fitopatología Agrícola del Perú”, 1947, mentions that Mr. Manuel García y Merino published in 1878 the first book of plant pathology in Peru, entitled “Las Epidemias de las Plantas en la Costa del Perú” (The Epidemics of Plants on the Coast of Peru) (11), in which he describes various abnormalities observed in plants that the author considered to be caused mainly by climatic variations, a concept that prevailed in that time.

In his same book, García Rada points out that the author of "Las Epidemias de las Plantas en la Costa del Perú” makes the first mention of the wheat rust in the country indicating that since 1687, it was seen as some kind of "dust" on wheat plants, reducing yields. Undoubtedly, it was the stem rust, due to the conditions of temperature and humidity prevailing in the coast of Lima, which favor the development of the disease.

At that time, the area of wheat sown came from seeds of the varieties introduced by the Spanish, probably with little genetic variability, which made them vulnerable to any disease outbreak, especially the change of virulence in the pathogen population. The pathogen must have been present in the planting areas but in low incidence. Presumably, the variety introduced was initially resistant to rust, and became susceptible to a new variant of the pathogen which probably emerged because of a

complex interaction among host, pathogen and environment, which favored the development of the disease with epiphytotic characteristic. Abbott (1) indicated that in 1928 there were 38 known physiological forms or strains of *Puccinia graminis tritici* with different ability to infect certain varieties of wheat. Postigo and García Rada (34), indicated that the number of races of the pathogen reached 250, in which more than 100 were found in the country during the period 1953-1960, and of these, race 189, detected only in Peru, was the most virulent of all, because of its ability to overcome all resistance genes known by then. This shows that pathogenic populations of *P. graminis tritici* differ from one area to another and from year to year, and why is tremendously difficult the development of resistant varieties of wheat and other cereal hosts to rusts pathogens

Foundation of the Escuela Nacional de Agricultura y Veterinaria de Santa Beatriz in 1902, by the Belgian Mission led by Eng. Jorge Vanderghem, and its moving to La Molina in 1933

Apart from the contribution of Mr. García y Merino as a milestone in plant pathology in Peru, the starting of this discipline is linked to the foundation of the Escuela Nacional de Agricultura y Veterinaria de Santa Beatriz (ENAV), Lima, Peru in July 1902 (33, 35), by the Belgian Mission conformed by teachers hired from the Gembloux Agricultural Institute, led by Eng. Jorge Vanderghem. Later the School was renamed as Escuela Nacional de Agricultura, (ENA), when the Veterinary section was separated in 1944.

The professional formation of agricultural engineers required the knowledge of the various problems affecting crops, among them diseases of plants. This discipline was considered since the beginning in the course of Botany.

In the Memory of the Silver Jubilee of the Escuela Nacional de Agricultura y Veterinaria, 1902 - 1927 (35), by its founding Director Eng. Jorge Vanderghem, is quoted that the chapter of Animal and Plant Pathology was taught in the course of Microbiology in the third year. In the fourth year, the course of "Botany included Plant Pathology, dealing with vegetable parasites diseases due to insects and other animals, and non-parasitic diseases."

With regard to teaching labs in plant pathology taught in four years of studies, only in the fourth year, practices were done in "microscopic identification of disease etiology, its evolution (disease cycle), review of insects producing diseases, their evolution, practical methods for controlling pests, and preparation of various fungicides and insecticides solutions and their application".

The Pioneers

The professors who taught the course of Botany including Plant Pathology were: Leopoldo Hecq, (1904-1906); Carlos Deneumostier, (1907-1911) and Julio Gaudron, (1912-1952).

The Peruvian government realized that the Escuela Nacional de Agricultura y Veterinaria should be not only a technical education center for training professionals, but also a center for experimentation and consultation on agricultural subjects. By proposal of Dr. Carlos Larraburre, founder of ENAV and Director of the Ministerio de Fomento (Ministry of Development), it was created the Farm School and the experimental stations of Sugarcane, Cotton, Animal Science, which later served as the basis for organizing a center for experimentation: the Central Agricultural Station, with different sections, among them, the Section of Botany and Plant Pathology to study cryptogamous diseases, their remedies and the way to prevent them. This section was named since 1913 Section of Botany and Plant Physiology, which had under his dependence the services of Parasitology and Plant Pathology, the herbarium, the Botanical Garden, and the Seed Control. This Central Agricultural Station was an entity that depended from the Escuela Nacional de Agricultura y Veterinaria.

The Plant Pathology course offered in the third year was split into General Pathology and Special Pathology, taught in the fourth and fifth year, respectively.

To complete the course in Plant Pathology dependent of the Section of Botany, Eng. Julio Gaudron added to the study of cryptogamous diseases, the pests caused by insects (Entomology), according to the criteria of certain European countries to consider under the name of the Plant Pathology both, diseases of animal and of plant origin. In 1933, when the Escuela Nacional de Agricultura moved to its new headquarter in La Molina, the teaching of Entomology was separated from Plant Pathology.

The Agricultural Experimental Station of La Molina

Another important event is the creation of the Estación Experimental Agrícola de La Molina (EEA) “Agricultural Experimental Station of La Molina” in August 1927 (21), by the Sociedad Nacional Agraria (National Agrarian Society), which was under its control until May 15, 1930, when by a Supreme Decree passed to depend directly from the Dirección de Agricultura y Ganadería of the Ministerio de Fomento.

The lack of experienced Peruvian technical personnel forced to look abroad for specialists to take charge of the different sections of the Station. Prior to the creation of the EEA of La Molina, the Sociedad Nacional Agraria installed two laboratories, one of Entomology led by Dr. Charles H. T. Townsend, which began operations in February 1926, and another of Plant Pathology, whose head was Dr. Ernest. V. Abbott, an American plant pathologist hired for three years, who took over in January 1927.

Dr. Abbott obtained his Bachelor's degree in Agricultural Sciences at Oregon State College. His M. S. and Ph.D. degrees in Plant Pathology were from the School of Agriculture of Iowa. He worked at home in the Department of Agriculture in the study of stem rust of wheat, and for the State of Louisiana in diseases of sugar cane and cotton.

The Plant Pathology Section of the Experimental Station initiates the establishment of a rigorous quarantine in the introduction of new sugarcane varieties to prevent entry of pests that had caused extensive damage in other countries. For this, a plot in the farm “La Chalaca”, located 7 km away from downtown Lima, near La Union Avenue (now Avenida Argentina), was acquired to establish a quarantine station.

In December 1927, it begins the investigation of insect vectors of the mosaic of sugar cane on the coast of the country to study the pattern of spread of this disease. The presence of the sugarcane mosaic in quarantine areas of the Escuela Nacional de Agricultura was confirmed by samples sent to the Experimental Station in Puerto Rico. The presence of this disease was later verified by Dr. Abbott in several farms of Lima neighboring valleys, which resulted in the destruction of all diseased material.

The Sociedad Nacional Agraria requested the Government to establish an agency to monitor plant health services. The Government by Decree of June 1, 1928 created the Junta de Sanidad Vegetal (Plant Health Board) as an advisory body of the Technical Department of Agriculture and Livestock; this Technical Directorate was created in 1918 under the Ministerio de Fomento. The current Ministry of Agriculture was created only in 1940.

The national pathologists of the Experimental Station of La Molina were formed by hiring of engineers graduated from the Escuela Nacional de Agricultura. Dr. Abbott had the initial collaboration of Mr. S. P. Vallejos as an assistant, and at his resignation, Eng. Germán García Rada replaced him in October 1, 1927. Eng. Garcia Rada graduated from the Escuela Nacional de Agricultura y Veterinaria in 1923. In 1937 the ENAV and the Sociedad Nacional Agraria provided him with a study stage in the United States of America, visiting the University of Minnesota where he got acquainted with Drs. E. C. Stakman, and C. M. Christensen, among others.

At the end of the contract of Dr. Abbott in June 1930, Eng. García Rada took over as head of the Plant Pathology Service of the Agricultural Experiment Station at La Molina, performing that role until 1948, when he was hired by the ENA to head the Department of Plant Pathology, where he remained until 1958.

The pathologists who integrated the professional staff of the Section of Plant Pathology of the EEA of La Molina in its initial stage were the Engineers Germán García Rada, Consuelo Pizarro Bazán de Segura (ENA '39), Rosendo Postigo Mendivil (ENA '46) who earned his M. S. degree from the University of Minnesota, Lily R. Brown Villar de Cornejo (ENA '47), who earned her M. S. degree from the University of Michigan, and Victor Revilla Morante, graduated in Argentina. Of this group, Postigo and Brown moved to the Escuela Nacional de Agricultura, and Bazán de Segura, to the Pontificia Universidad Católica del Perú in Lima to teach the course of Plant Pathology and also

to perform advisory and consultancy work at the Estación Experimental Agrícola de Ica, the Estación Experimental Agrícola de Agricultores de Cañete and to work for the Sociedad Nacional Agraria between 1960 and 1966. It is noteworthy to mention that in the Estación Experimental de Cañete, the concept and use of Integrated Pest Control, (Integrated Pest Management now) was born, by the outstanding work of its entomologists in pest management of cotton. This Station is now fully disabled. The places left by Postigo, Brown and Bazán de Segura, were covered by Engineers Segundo Dongo Denegri (ENA '57), Arturo Osores Durán (ENA '55) and Luis Vargas Rivera (ENA '58), with a Master degree in Costa Rica the first one, and in USA the remaining two.

Between 1933 and 1948, Eng. German García Rada taught the course of Special Plant Pathology for the 5th year, while Eng. Julio Gaudron, in the same period, was in charge of the General Plant Pathology course for the 4th year; both courses had an 8-month lesson period. From 1949 on, Garcia Rada took over the courses in the area of Plant Pathology. During his career in the ENA, in addition to his teaching duties, García Rada was, between 1948 and 1958, Head of the Department of Plant Pathology and from 1955 to 1958, Director of the ENA. As noted, the course of Plant Pathology was separated from Botany, and was divided into what is now known as General Plant Pathology and Applied Plant Pathology. The Engineer Victor Revilla was hired part time to teach the Applied Plant Pathology course, keeping his post of Head of the Department of Plant Pathology at the Agricultural Experiment Station of La Molina.

Another milestone in the Peruvian plant pathology was the creation in 1942 of the Estación Experimental Agrícola in Tingo María, whose Plant Pathology Department was in charge of Engineer Javier Díeguez Castro (ENA '44), who contributed with many studies on crop disease from the jungle region. Engineer Felipe Wong Ley (UNALM '61) also joined the Experimental Station obtaining a Master degree in Costa Rica. It should be noted that by years 62 to 63, that Experimental Station served as the basis for the creation of the Universidad Nacional Agraria de la Selva, Tingo María in which the course of plant pathology is offered in its Agronomy Faculty.

To the faculty of the Department of Plant Pathology at the Escuela Nacional de Agricultura joined Engineer Mario Rondón de Olazábal, graduated from the ENA in 1954, with a M. S. from North Dakota State University, and Engineer Teresa Ames de Icochea, graduated from the ENA in 1956. Both professionals received their Ph. D degrees at North Dakota State University in August 1967 and North Carolina State University in 1966, respectively. Dr. Rondón died prematurely after earning his Ph.D. degree. Dr. Ames de Icochea, with the participation of Dr. Edward R. French of the North Carolina State University Mission to Peru contributed to the development of this discipline, organizing the professionals working in plant pathology from the agricultural universities of the country, programming and teaching a six week summer course in

Plant Pathology as a refresher course for plant pathologists from different universities in Peru, most of them self-taught. The course was conducted at the facilities of the Universidad Nacional Agraria La Molina on February 6, 1967. This event allowed the organizers to have an exact idea of the status of plant pathology in the country, to suggest trips for young teachers to pursue graduate studies abroad and, at the initiative of the course organizers and participants to it, it was agreed to establish an association of Peruvian plant pathologists, that materialized in 1967 with the founding of the Asociación Peruana de Fitopatología, (Peruvian Association of Plant Pathology) (APF) as an entity to group the plant pathologists of the country, with the aim of exchanging experiences in their research work and to divulge the results among the associates for application in teaching and for solving phytosanitary problems. The Notarial Deed of constitution of the APF was in June 21, 1968. Dr. Teresa Ames de Icochea was elected as the first President of our Association. The APF is affiliated to the Asociación Latinoamericana de Fitopatología (Latin American Phytopathological Association) (ALF) and our members can use its journal “Fitopatología” to publish their research papers.

The North Carolina State University Mission to Peru:
The arrival of this Mission to Peru was linked to the Ministerio de Agricultura (Ministry of Agriculture) and the Universidad Nacional Agraria La Molina; his goal was to support research on potato crop carried out by the Programa Nacional de la Papa of the Servicio de Investigación y Promoción Agraria (SIPA-EEA de La Molina), and the Programa de Investigación de Papa of the UNALM.

Among the different professionals that came with this Mission was Dr. Edward R. French, who arrived to Peru on September 2, 1965 as Advisor in Plant Pathology. Dr. French received his M. S. from the University of Minnesota and his Ph.D. at the North Carolina State University. Besides his many functions as adviser, he worked on the identification of pathogens of crops in different agricultural areas of this country, he did an excellent work on the potato bacterial wilt *Ralstonia solanacearum*, the preservation of fungus *Fusarium*, etc., and taught in the Graduate School of UNALM, the course of Techniques and Methods in Plant Pathology for students of this discipline, also participating in the counseling master's thesis. The trajectory of Dr. French in the country is extremely profitable and profuse, shown by the contribution to plant pathology research expressed in his research and publications.

On the basis of the Mission of the North Carolina State University, it was created the International Potato Center (IPC) in La Molina on January 20, 1971, although for some people, the date was January 25, 1972, when the building in La Molina was finished. The Department of Plant Pathology of the IPC, which was headed by Dr. French, has played an important role in the development of our discipline in the country. The IPC has supported since its inception many research papers in the field of virology, bacteriology, mycology and nematology, by plant pathologists of the UNALM and of

many other universities and institutions of the country through the use of its facilities, equipment and materials, and the assistance of its technical personnel.

The Diagnostic Clinic is a unit of the Department of Plant Pathology of the UNALM created to provide service to the community at local, regional and national levels. It maintains a well-stocked database of disease problems of plants grown in the country, its etiology, symptoms and distribution as well as recommendations for their management and control. It also maintains a fungi collection (Micoteca) for teaching and research purposes as well as to provide samples of diseased material for the Museum.

Creation of the Plant Pathology specialty, in the Graduate School of the Universidad Nacional Agraria La Molina

The creation of new universities with faculties of agriculture in the country required pathologists for teaching purposes. Many of them that did not have such professionals had to hire the services of trained plant pathologists from the UNALM, or make arrangements to supply this deficiency. An example of this was the support that the Department of Plant Pathology of the UNALM provided to the Department of Plant Health of the then Universidad Técnica de Piura (now Universidad Nacional de Piura), by sending Eng. Ricardo Mont to teach the Plant Pathology courses for students of agronomy, class of 1966, to fulfill their curriculum. This work was afterward shared with Eng. Luis Lazo for a second group of students who also could not attend in due time the plant pathology courses. Both lecturers took advantage of their stay to implement a plant pathology laboratory. In 1967 that university hired, by proposal from Dr. Teresa Ames de Icochea, Chairman of the Department of Plant Pathology of the UNALM, the services of Eng. Martin Delgado Junchaya. At present some universities of the country has overcome this limitation by sending its graduates to obtain Masters degrees in UNALM or abroad. It should be noted that the UNALM, through its Graduate School, is the only university in the country that offers Master degrees in this field. Some universities of provinces offer Masters degrees in related areas such as the Universidad Particular Antenor Orrego which offers a graduate degree in Agricultural Sciences in the field of Crop Protection.

The creation of the specialty of Plant Pathology in the Graduate School of the UNALM in 1967 permitted to correct this deficiency by training of professionals for a degree of Master of Science in this discipline, who before its creation, had to study abroad (USA, Europe, Mexico, Costa Rica, etc.). The professors who initiated and who set the course of this specialty in the Graduate School were Dr. Teresa Ames de Icochea, Dr. Enrique Fernandez-Northcote, M. S. César E. Fribourg, M. S. Ricardo Mont, and M. S. Rosendo Postigo. The M. S. Jaime Castillo came from the Ministry of Agriculture to the UNALM to replace Eng. Rosendo Postigo after his retirement in 1977. In addition, Drs. Edward French and Parviz Jatala belonging to the staff of the IPC, the latter in the area of nematology, have been appointed as visiting professors. To this group have been

incorporated the nematologists Drs. Manuel Canto and Elsa Carbonell, as well as the Masters Leonor Mattos, Walter Apaza, Liliana Aragón, Carlos Cadenas, and Tomás Melgarejo. The work of this faculty has permitted the formation of plant pathologists from students graduated at the UNALM, or at any other domestic or foreign university.

Peruvian Congress of Plant Pathology

The Peruvian Association of Plant Pathology has organized since its beginning until 2010 twenty one Congresses of Plant Pathology. The first three were host in Lima and held annually in 1971, 1972 and 1973. Since 1975, the remaining 18 have been conducted every two years and in a decentralized way in Lambayeque (1975), Ayacucho (1977), Piura (1979), Cajamarca (1981), Ica (1983), Huánuco (1985), Lima (1987), Lima (1989), Arequipa (1992), Tingo María (1994), Chiclayo (1996), Pucallpa (1998), Piura (2000), Tarapoto (2002), Huaraz (2004), Cajamarca (2006), Arequipa (2008), and the last one in 2010 in Tarapoto. For 2012, the city of Ica is scheduled to host the 22nd Congress.

Peruvian plant pathologists of the generation of the sixties are:

Jaime Castillo Loayza, Martin Delgado Junchaya, Enrique Noé Fernández-Northcote, Javier Franco, César E. Fribourg, Luis Lazo Anaya, Ricardo M. Mont Koc, Luis Salazar Márquez and Marco Soto Pfucker.

Castillo earned his M. S. from University of California, Davis; Delgado, his Doctorate in Agricultural Sciences at University of Göttingen, Germany; Fernández-Northcote, his M. S. from University of California, Davis and his Ph. D. at University of Wisconsin; Franco, his M. S. and Ph. D. at Rothamsted Experimental Station, University of London, England; Fribourg, his M. S. from University of Wisconsin; Lazo, his M. S. from North Carolina State University; Mont, his M. S. from University of Minnesota; Salazar, his Ph.D. from University of Dundee, Scotland; and Soto, his M. S. and Ph. D. from Cornell University.

Fernández-Northcote, Fribourg, Lazo, Mont and Soto have been involved in teaching undergraduate courses of Plant Pathology in the UNALM, together with professors Postigo, Brown and Ames. Delgado taught at the Universidad Nacional de Piura and is currently at the Universidad Particular Antenor Orrego (UPAO), Franco and Salazar were hired to work in the Department of Plant Pathology of the International Potato Center, Castillo worked in the Viticulture Nursery of the Ministry of Agriculture until he moved to the UNALM.

Plant pathologists graduated from the UNALM Graduate School:

Since the creation of the Plant Pathology specialty in the Graduate School of the UNALM until 2010, 79 plant pathologists have graduated. They are: Jorge Abad Vidal, Gloria J. de Abad, Pedro Aley Minaya, Luis Alvarez Bernaola, Raúl Anguiz, Walter Apaza Tapia, Liliana Aragón Caballero, Jesús H. Arcos Pineda, Enrique Arévalo

Gardini, Evelio Astocaza Pérez, Fernando Barrantes del Águila, Ciro Barrera Rojas, Lis Barrientos Barrientos, Carlos Cadenas Giraldo, Manuel Canto Sáenz, Enrique Castañeda P., Carolina Cedano S., Lorenzo Chang Sam, Regina K. Cruzado G., Christian Door Remotti, Judith Echegaray B., Gianfranco Egoavil Jump, Josué Flores Gómez, Segundo Fuentes D., Delia Gamarra Gamarra, Víctor R. González Flores, Janet Gonzales Valdivia, Alberto Gonzales Verástegui, Jesús Gaudencia Guerrero C., Walter Gutiérrez Cáceres, Guillermo Huamaní Apaza, Oscar Hidalgo López, Ana Hurtado Alendes, Lourdes Jarecca Rivera, Javier Javier Alva, Alberto Jiménez S., Henry S. Juárez Soto, Alberto Julca O., Betsabé León Ttacca, Charlotte Parker de Lizárraga, Jorge Llontop Llaque, Julio Marín Horna, Kadir Márquez Dávila, Leonor Mattos Calderón, Violeta Medina Córdova, Tomás Melgarejo Gutiérrez, Libia Moreno Grandez, Milagros Ocampo Pazos, María Olivos Farro, Angel Oviedo Aleman, Wilmer Pérez Barrera, Robert Richard Rafael Rutte, Rubí M. Raymundo Carhuapoma, Luis Reymundo Meneses, Carlos Rodríguez Koch, Jorge D. Romero Pajares, Ladislao Romero Rivas, Hilda V. Silva Rojas, Segundo Tafur S., Josefina Takahashi Sato, Rolando Talavera Pineda, Liz Tarazona Matos, James Tirado Lara, Hebert Torres Martínez, Edgardo Torres Vera, Demetrio Untiveros, Arturo Urbizagástegui B. y Olga Vallejos Vílchez. From them, Jiménez and Hidalgo graduated in 1970; Cruzado, León and Romero did it in 2010.

The foreign students who graduated are: Antonio Gandarillas Antezana, Arturo Moreira Ríos and Mario Coca Morante (Bolivia), Armando Rodríguez Benavides and José Luis Zapata Pareja (Colombia), Franklin Santillán Santillán and Jorge Luis Piedra Naranjo (Ecuador), Edgar García Chiu and Nelson R. Pantoja García (Guatemala), Rodrigo A. Morales Arauz (Panamá), and Betty Yolanda Paz Zambrano (Venezuela).

Among those who have obtained the Ph. D. degree are: Manuel Canto (Cornell University), Jorge Abad, Gloria de Abad, Walter Gutiérrez and Oscar Hidalgo (North Carolina State University), Josefina Takahashi (University of Birmingham, England). Elsa Carbonell obtained her degree of Doctor in Sciencie in the area of Nematology in Belgium.

Among those who have dedicated to teach plant pathology in the UNALM are: Apaza, Aragón, Cadenas, Canto, Carbonell, Mattos, Melgarejo; González Flores also taught in the UNALM the course of Forest Pathology in the Faculty of Forestry. Door, Gutiérrez, y Rodríguez also worked in the Department of Plant Pathology of the UNALM, but after a while they migrated to other activities. Others have returned to their universities of origin and/or were hired by those study centers, like Arévalo and Egoavil (Univ. Nac. Agraria de Tingo María), Barrantes del Águila (Univ. Nac. San Cristóbal de Huamanga), Cedano (Univ. Nac. de Tumbes and Univ. Nac. de Trujillo), Gamarra and Untiveros (Univ. Nac. del Centro, Huancayo), Jiménez, Llontop, Olivos and Vallejos (Univ. Nac. Pedro Ruiz Gallo, Lambayeque), Torres Vera (Univ. Nac. Hermilio Valdizán, Huánuco),

Javier Javier Alva (Univ. Nac. de Piura), Tafur (Univ. Nac. de Cajamarca) and, some others, by scientific organizations like the IPC or abroad.

Other pathologists graduated from the UNALM are serving in the National Institute of Agrarian Innovation (INIA) of the EEA of La Molina; Arcos, in INIA Puno; Echegaray, Marín, Flores Gómez and Tirado, in the National Animal and Plant Health Service (SENASA). Hidalgo was hired by the International Potato Center.

Engineer Armando Jarama taught at the Universidad Nacional de la Amazonia Peruana, Iquitos. Engineers Antonio Garmendia and Alejandro Velazco, were professors of plant pathology courses at the Universidad San Antonio Abad, Cusco and Universidad Nacional del Altiplano, Puno, respectively. Biologist Angel Diaz was in charge of the plant pathology courses at the beginning of the Universidad Agraria del Norte, now Universidad Nacional Pedro Ruiz Gallo, Lambayeque. Engineer Julio Valladolid taught at the Universidad Nacional de San Cristobal de Huamanga, Ayacucho.

In addition to plant pathologists trained at the Graduate School of the UNALM, some universities in the country have formed their own professionals abroad. Thus, we have among others, Drs. Edgar Rodriguez (Piura), Aurelio Martos (Cajamarca), Victor Otazú and Basilio Salas (Puno). Other pathologists such as Javier Romero, Ana Maria Hinostroza, Oscar Masías, etc. migrated to foreign countries to obtain their degrees, settling there afterward for work.

Peruvian universities with faculties of Agronomy

The following universities have departments of plant pathology whose plant pathologists have been trained in the UNALM or in foreign universities:

1) Universidad Nacional Agraria La Molina, Lima
2) Universidad Nacional Santiago Antúnez de Mayolo, Ancash
3) Universidad Tecnológica de los Andes, Apurimac
4) Universidad Nacional San Agustín, Arequipa
5) Universidad Particular Católica Santa María, Arequipa
6) Universidad Nacional San Cristóbal de Huamanga, Ayacucho
7) Universidad Nacional de Cajamarca, Cajamarca
8) Universidad Nacional Daniel Alcides Carrión, Cerro de Pasco
9) Universidad Nacional San Antonio de Abad, Cusco
10) Universidad Nacional de Huancavelica, Huancavelica
11) Universidad Nacional Hermilio Valdizán, Huánuco
12) Universidad Nacional Agraria de la Selva, Tingo María, Huánuco
13) Universidad Nacional San Luis Gonzaga, Ica
14) Universidad Nacional de la Amazonía Peruana, Iquitos
15) Universidad Nacional del Centro, Huancayo, Junín
16) Universidad Nacional Pedro Ruiz Gallo, Lambayeque
17) Universidad Nacional José Faustino Sánchez Carrión, Huacho, Lima

18) Universidad José Carlos Mariátegui, Moquegua
19) Universidad Nacional de Piura, Piura
20) Universidad Nacional del Altiplano, Puno
21) Universidad Nacional Jorge Basadre Grohmann, Tacna
22) Universidad Nacional de San Martín, Tarapoto
23) Universidad Particular Antenor Orrego, Trujillo
24) Universidad Nacional de Trujillo, Trujillo
25) Universidad Nacional de Tumbes, Tumbes
26) Universidad Nacional de Ucayali, Ucayali

Contribution of plant pathologists in Peru

The contribution of plant pathologists in Peru can be summarized as follow:

Julio Gaudron (15), mentioned in his 1927 report as Chief of the Section of Botany of the ENAV, the involvement of teachers of the Section of Applied Botany in the conformation of the Plant Pathology Committee which was formally organized in August 1905, and whose members were the Director of the same, Engineer Jorge Vanderghem, L. Dubosc (Viticulturist), F. Chabert (Enologist), and the Professor of Botany, Engineer Leopoldo Hecq, who was later replaced in 1907 by Vanderghen, and from 1908 to 1910 by C. Deneumostier. The members of that commission issued the following reports: Hecq: "Treatment of potato with Bordeaux mixture", in 1905, and "The potato disease", in 1905 and 1906; Vanderghem: "Diseases of cherimoya and wheat", and "The Fitoftora infestans (sic), or disease of the potato", both in 1907. Gaudron emphasized that the most important work of the Commission of Plant Pathology was the control of *Phytophthora infestans* causing the potato late blight in the valley of Lima, by using Bordeaux mixture.

Gaudron's work was focused on the areas of entomology and plant pathology. There are numerous reports concerning to insect problems especially in cotton and pome fruits. In 1924, he reported "the reduction of resistance in Tangüis cotton to the "Cotton Wilt". The Plant Pathology Committee was deactivated at the end of 1909, and its functions were assumed by the Section of Botany of the ENAV. At that time, the Law No. 1221 on “Policía Sanitaria Vegetal” (Plant Health Police) was promulgated, granting the Government the broadest faculties to deny the entry or introduction of any kind of seeds and propagating material, without due guaranties or securities to be exempt from dangerous insect or disease for crops in the country. In 1911 the law was regulated establishing the use of phytosanitary certificates and license of internment.

Ernest V. Abbott (1), in his work at the Plant Pathology Section EEA La Molina carried out inspection trips looking for plant diseases in the country, indicating that 111 plant diseases had been identified in the following crops: sugar cane, 8; cotton, 8; corn, 6; coffee, 7; potato, 12; wheat, 8; barley, 5; alfalfa, 4; fruit, 21; vegetables, 18; other crops,

14. Among the diseases that deserved special reports were: “Mosaic of sugar cane”, "Cotton wilt in the region of Lima”, and “Fungal diseases of cotton in the Department of Piura". Other reports produced were: "Plant pests studied in the Departments of Piura and Lambayeque", "Fungal plant pest in the valleys of Chicama, Tambo, Arequipa and Cuzco", "Fungal diseases of cotton in the Department of Piura" and, in collaboration with Dr. Charles H. T. Townsend, "Diseases and pests observed in crops of the Central Mountain" (Departments of Junín and Huánuco).

The EEA La Molina published two circulars by him: "The mosaic disease or variegation of sugar cane, with notes on *Aphis maidis*" prepared jointly with the entomologist Dr. Charles H. T. Townsend, and "the scab and late blight of potato".

The identification work of diseases was complemented with field trials evaluating wheat, oats and barley germplasms from the United States, for their response to stem rust in coastal and highland conditions; the chemical control of potato late blight using Bordeaux mixture at different concentrations; selection of strains of the Tangüis cotton variety resistant to cotton wilt in field trials by using seeds from the Experimental Station in Cañete, seeds from plants that had survived in infested areas in the Rimac valleys in 1928, and seeds from the farm of Mr. Tangüis in Pisco. His work of disease identification permitted to determine the presence of (stem) rust in wheat crops in Trujillo, and of wheat bunt, *Tilletia tritici* (*T. caries*), in the highlands.

Abbott mentioned the presence of three “mosaic” or virus like diseases observed in commercial potato fields around Lima: "moderate mosaic", "leaf roll" and "spindle tuber" (the aforementioned spindle tuber symptom probably was caused by some other pathogen or by abiotic factors), and indicated that the virus is carried in the seed and transmitted from diseased to healthy plants through the insect vector, the common potato aphis. He carried out field tests to demonstrate the effect of these diseases on yields.

Additionally, he studied the "anthracnose" disease attacking avocado in Santa Eulalia. This disease also was observed in Surco, San Bartolomé, causing major damages. He recommended control measures.

Among the laboratory work, he began a study of the genus *Fusarium* in Peru, with emphasis on the species that cause diseases such as "decay" in cotton, potatoes, and coffee, "rot" in potato tubers, and corn roots, etc. He also made collections of diseased plants in different places of the country, finding new diseases. This work was complemented by the preparation and preservation of specimens of diseased plants for the Museum.

Germán García Rada (12) in his first report as Assistant Plant Pathologist in charge of the Section of Plant Pathology of the EEA of La Molina, since June 1930, indicated that

the labor realized was to continue with the field trials and laboratory works to identify the different fungi that attack plants, initiated by Abbott. The field trials carried out were "the wheat stem rust", for evaluating the behavior of varieties to the pathogen. Wheat hybridizations were also carried out to study the response to this disease in subsequent generations. In order to control the disease, a sulfur fungicide applied as dust was tested, finding some inconveniences in the application technique, timing of application, etc., so it was recommended to make adjustments in the timing, dose and number of applications, according to our conditions. Behavioral assessments of cereals also were made with different American barley varieties and a “naked“ barley from Arequipa. The material evaluated was attacked by stem rust and "helminthosporium oval leaf spot"; the attack reached such a level that many varieties did not form grains, or if they did, they were vain or "sucked", with yields close to zero. It was detected also the presence of "root rot" caused by *Fusarium* sp. The only barley variety with acceptable yields was "Malting 326" which had a greater resistance to rust and helminthosporium oval leaf spot.

In the wheat field tests it was also observed the presence of leaf rust, *Puccinia triticina* (*Puccinia recondita tritici*), oval leaf spot, *Helminthosporium sativum* (*Bipolaris sorokiniana*), powdery mildew, *Erysiphe graminis* (*Blumeria graminis tritici*), and loose smut, *Ustilago tritici*. In barley, powdery mildew was another disease with a high intensity of attack, while the loose smut, *Ustilago nuda* occurred sporadically.

In the study of control of "potato late blight”, the Bordeaux mixture was compared to a copper salt formulation, finding better control with the former fungicide, which was reflected in higher yields, and lower cost. In the study of "mosaic of potato" it was found a variety (name not mentioned), that showed no symptoms of the disease; all native potatoes with yellow flesh tested showed mosaic symptoms and low yields. The trial showed a large percentage of potato plants attacked by *Rhizoctonia solani*. The disinfection of seed tubers with mercury dichloride did not give positive results. For "cotton wilt" caused by *Verticillium albo-atrum*, a trial was conducted at the field level to test disease resistance in different varieties of cotton from the United States, Egypt, and selections of local cottons Tangüis, and algodón "País" from Piura. The American varieties developed for resistance to the wilt disease were heavily attacked and killed. Tangüis selections also showed high rates of infection, but it was possible to find individual plants with little pathogen attack. This material was selected and harvested individually for subsequent tests.

García Rada reported that in the second half of 1930 new crop diseases were found. They were: powdery mildew (*Oidium* sp.) of lucumo, *Lucuma obovata*; leaf brown spot (*Mycosphaerella fragariae*) of strawberry, *Fragaria* spp; tumor of the neck and root (*Urophlyctis alfalfae*) of alfalfa, *Medicago sativa*; rye stem rust, *Secale cereale*, (*Puccinia graminis secalis*). He also indicated that Dr. Abbott, during his tenure as

Head, prepared the bulletin "Diseases of Cultivated Plants in Peru", which describes all diseases found to the date of his retirement of the country. In addition, the Annual Memory of the California Avocado Growers published his article "Anthracnose of the avocado in Peru".

Germán García Rada and J. A. Stevenson (14) published in 1942 "La Flora Fungosa Peruana. Lista Preliminar de Hongos que atacan a las plantas en el Perú" (The Fungous Flora of Peru. Preliminary list of fungi that attack plants in Peru). In 1947, García Rada (13) published his book, "Fitopatología Agrícola del Perú" (Agricultural Plant Pathology of Peru), as fruit of his 20 years experience working in this discipline.

Consuelo Bazán de Segura (4), published in 1965 her book "Enfermedades de Cultivos Tropicales y Subtropicales" (Diseases of Tropical and Subtropical Crops), and in 1975 (6), "Enfermedades de Cultivos Hortícolas y Frutícolas" (Diseases of Horticultural and Fruit Crops). Her contribution to plant pathology also occurs with the publication of "Principales Enfermedades de las Plantas en el Perú" (Main Plant Diseases in Peru), published in 1959 (3), and the "Relación de Enfermedades y Microorganismos Patógenos aislados de plantas cultivadas, forestales y ornamentals en el Perú" (List of Diseases and Pathogens isolated from cultivated, forest and ornamental plants in Peru), published in 1973 (5).

For non graduated Plant Pathology courses taught in the UNALM, students were provided with booklets on the topics to be discussed. This material was afterward compiled as mimeographed text. Thus there are: Fernandez-Northcote, Mont and Fribourg, 1973 "Agricultural Plant Pathology" (7); Icochea, Teresa Ames de, 1974 "General Plant Pathology" (16); Mont, 1976 "Plants Disease Control" (22); Fribourg, 1977 "Agricultural Plant Pathology, Volume I: Diseases Caused by Viruses, Viroids and Mycoplasmas" (9); Mont and Fernandez-Northcote, 1978 "Agricultural Plant Pathology, Volume II: Bacterial and Fungal Diseases" (32).

Rosendo Postigo and Germán García Rada (34), and Teresa Ames de Icochea (17), published in 1977, for the commemoration of the Diamond Jubilee of the UNALM, two papers on plant pathology in Peru: "La Fitopatología en la Escuela Nacional de Agricultura y Veterinaria del Perú, en el período 1919-1960" (The Plant Pathology at the National School of Agriculture and Veterinary of Peru during period 1919-1960), and "La Fitopatología en la Universidad Nacional Agraria La Molina" (Plant Pathology at the National Agrarian University of La Molina), respectively. They gave details of the beginnings of this discipline in the country, highlighting facts about the courses offered, faculty pioneers, the contribution of the Engineer Germán García Rada as the first Peruvian plant pathologist, and the impetus that was given to teaching this Science with the collaboration of the technical staff of the Plant Pathology Service of the EEA de La Molina, after its moving from the initial Campus at Santa Beatriz to the current one in La

Molina; the evolution in time of the specialty, the postgraduate training of professional plant pathologists as a specialty within the study of Agronomy and as part of multidisciplinary teams in various Research Programs at the UNALM, and to provide teachers for different Universities and Plant Health Institutions of the country.

Edward French and Teddy T. Hebert (8), published in 1980 the book "Métodos de Investigación Fitopatológica" (Phytopathological Research Methods), which is used as a text for the course on "Técnicas y Métodos de Fitopatología", (Techniques and Methods of Plant Pathology) in the specialty of Plant Pathology in the Graduate School of the UNALM.

Teresa Ames de Icochea, translated into Spanish in 1980, the "Compendium of Potato Diseases" and in 199, the "Compendium of Sweet Potato Diseases" with permission from The American Phytopathological Society, which have been published by the International Potato Center. The Spanish versions are titled as: "Compendio de Enfermedades de la Papa" (18), and "Compendio de Enfermedades de la Batata (Camote, Boniato)" (21). In 1996, she published with other authors the field guide "Sweetpotato: Major Pests, Diseases, and Nutritional Disorders" (2), and finally in 1997, her book "Enfermedades Fungosas y Bacterianas de Raíces y Tubérculos Andinos" (Fungal and Bacterial Diseases of Andean Roots and Tubers) (20).

César Fribourg (10), published in 2007 his book "Virus, Viroides y Mollicutes de las Plantas Cultivadas en el Perú" (Viruses, Viroids and Mollicutes of Cultivated Plants in Peru) as fruit of his experience of more than 40 years working in the field of Virology.

Ricardo Mont, published between 1993 and 2008 the following books: "Principios del Control de Enfermedades de las Plantas" (Principles of Plant Diseases Control) (23), "Manejo Integrado de Enfermedades de las Plantas" (Integrated Plant Disease Management) (29), "El Control Biológico como componente del Manejo Integrado de Enfermedades de las Plantas" (The Biological Control as component of Integrated Plant Disease Management) (30) and "Enfermedades de la Cebada, el Trigo y la Avena. Identificación y Manejo Integrado" (Diseases of Barley, Wheat and Oats in Peru. Identification and Integrated Plant Disease Management) (31), and prepared by request of the National Animal and Plant Health Service, SENASA, the following manuals: "Manual de Enfermedades de los Cítricos" (Handbook of Citrus Diseases) (24), "Los Cítricos y sus Enfermedades, Segunda parte" (Citrus crops and its Diseases, Part II) (25), "El Papayo y sus enfermedades" (Papaya crops and its diseases) (26), "El Palto y sus enfermedades" (Avocado crops and its diseases) (27), "El Mango y sus enfermedades" (Mango crops and its diseases) (28).

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