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JOHANNA WESTERDIJK: PIONEER LEADER IN PLANT PATHOLOGY

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Johanna Westerdijk, "Hans" to her friends, was born over a century ago on January 4, 1883, in Amsterdam, where her father was a general practitioner. Her mother's family came from France. These French genes, she said, were responsible for her temperament, vitality, and fondness for a glass of good wine. As a young girl she knew quite well what she wanted. In elementary school she refused to participate in plain needlework training; she read stories to the other girls instead. She remarked to her teacher that she would make sure to earn enough to have all domestic duties done for her. She had a fine ear for music and originally intended to become a professional pianist, but when she was old enough to decide her own future a persistent neuritis in one arm made this impossible.

As she also had a keen interest in botany, she decided at the age of 17 to enter Amsterdam University to attend the lectures of the famous botanist, Professor Hugo de Vries. Initially he denied her permission to take the course in practical work because she was a girl, and so she turned to her old friend Dr. C. J. J. van Hall, who was then assistant to Professor Ritzema Bos, the first director of the Phytopathological Laboratory Willie Commelin Scholten in Amsterdam: a foundation established by Mrs. and Mr. Scholten in memo-

[1]Professor L. C. P. Kerling died at the age of 85 while this manuscript was in the editing process.

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rial of their son, Willie Commelin. Its history is described by Kerling (3, 4). There Johanna became interested in phytopathology. After finishing her biological studies at Amsterdam, she spent some time in Munich working in the laboratory of Professor Goebel, and later she studied in Zurich under Professor H. Schinz. There she got her doctor's degree for a thesis entitled *Die Regeneration der Laubmoose* (The regeneration of mosses). Back in the Netherlands she was offered the directorship of the W. C. Scholten Laboratory in 1906, when she was only 23 years old.

In 1907 Dr. F.A.F.C. Went, professor of general botany at the State University of Utrecht, asked Johanna Westerdijk to care for a collection of pure cultures of fungi that had been established as a result of discussions at a meeting of the "Association Internationale des Botanistes" at Leiden in 1903.

The collection contained about 80 cultures, some of tropical origin. After some years Johanna Westerdijk called this collection the "Centraal Bureau voor Schimmelcultures," CBS (Central Bureau of Fungus Cultures). The CBS became a foundation, and, under her active leadership, this collection expanded to over 10,000 strains of more than 6,500 different species of filamentous fungi, yeasts, and actinomyces. At present there are 30,000 strains of 8,000 species.

The aim of the CBS was, and still is, to keep a large variety of fungi in culture on artificial media for distribution to researchers all over the world. Moreover, cultures can be sent to the CBS for identification. Because Johanna Westerdijk initially studied a diversity of plant diseases, she was able to enrich the collection with many specimens isolated from crop plants. Great use was made of the CBS cultures, first mainly for biological purposes and later, after the discovery of penicillin, by many national and international industrial organizations.

Despite the gifts and legacies received (e.g. from Mr. Odo van Vloten, a planter from Indonesia), the financial base of the CBS remained uncertain for a long time. Its income was only sufficient to allow the mycologists a salary too small, in fact, to live on. That many of them continued working there was due to their love of mycology and loyalty to Johanna Westerdijk. Later the situation improved when the Central Organization for Applied Scientific Research (TNO) in the Netherlands took over the CBS. A department for medical mycology and a division for research of yeasts were added. Eventually, the CBS became an institute of the Royal Netherlands Academy of Arts and Sciences. Altogether, more than 70 publications on the taxonomy of fungi (including parasites of man) have been written by Westerdijk's collaborators at the CBS during her directorship. Also, an elaborate study of the yeasts was compiled. (5).

Gradually, the CBS became a famous institution, and it is evident that its operation entailed an extensive correspondence in many foreign languages. Moreover, the cultivation of fungi in pure culture is by no means a simple uniform technique. This was clearly explained by Johanna Westerdijk (12), who told how the founder of the fungal collection, F.A.F.C. Went, had learned the cultivation of fungi in pure culture on nutrient gelatine and nutrient agar from A. de Bary, to whom he went in the 1880s. By keen observation Westerdijk learned that a variety of natural substrates as well as changes in temperature could stimulate growth and sporulation.

Johanna Westerdijk considered the collection her fungus "garden." Many of her students were especially attracted to this way of growing microorganisms. Dr. Gerda Bunschoten dedicated a life's work to the CBS collection.

In 1910 A. van Luijk, a young farmer and practical potato selectionist very interested in plant disease problems, became a permanent assistant at the

CBS. He developed a phenomenal knowledge of mycology. For more than 25 years he was a tremendous help to Johanna Westerdijk. This self-made man published the results of his investigations in three languages. He became highly interested in antagonism between fungi (8). For this pioneer work he won an honorary doctor's degree from the Utrecht State University in 1946.

During the early years of her directorship of the Phytopathological Laboratory W. C. Scholten (WCS), Dr. Westerdijk followed the tradition of advising farmers as well as she could. She studied a variety of plant diseases, first alone, and later with the help of Van Luijk and others. Her attention went mainly to fungal diseases of crop plants. As she could not isolate a pathogen from diseased oats growing on acid soils, she suggested a physiogenic cause; this was later confirmed by others, just as her conclusion in 1910 (9) that tomatoes with mosaic symptoms in greenhouses suffered from a virus not identical with that causing tobacco mosaic. Since phytopathology is an applied science, she not only studied the cause of a disease but also tried to find means for its effective control. In most of the Annual Reports of the Phytopathological Laboratory W. C. Scholten, tests with new chemicals were recorded among others for seed disinfection.

In 1917 Dr. Westerdijk decided to restrict her attention to fewer diseases in order to find more time for detailed research. At that time, phytopathology still being in its descriptive period, the life cycles of many pathogens were elucidated. [For more details see ten Houten (2).] One is impressed by the amount of work involved, the careful planning of Dr. Westerdijk's experiments, her keen observation of disease symptoms, including morbid anatomy, and the logical and clear discussion of the results. Realizing that all experiments then had to be carried out in the open or in a very small glasshouse without means to control the temperature and the humidity, it is not surprising that she laid stress on keeping humidity high to allow a parasitic fungus to enter a host.

Tree diseases got Dr. Westerdijk's special attention. First she studied diseases caused by *Armillaria mellea, Fomes annosus,* and *Stereum purpureum* on orchard trees; later she studied *Gloeosporium* spp. on oaks and planes (together with Van Luijk), and *Nectria galligena* and bacterial galls on poplars. In 1919 an unknown elm disease was incidentially observed in the south of the Netherlands. In 1920 the situation became alarming, when thousands of Dutch elms *(Ulmus hollandica-belgica)* planted along roads and dikes died. No wonder that Dr. Westerdijk paid so much attention to the disease. With the help of Beatrice Schwarz and Christine Buisman, she found that *Ceratocystis ulmi* was the cause. In a well-written publication (13), Westerdijk's opinion was clearly enunciated: the disease would not disappear and that we had to search for genetically resistant elms. As a "reward" for this work the disease is still called the "Dutch elm disease."

Johanna Westerdijk was fond of traveling. And she traveled! In 1913 she went to the former Dutch East Indies to get acquainted with the diseases of tropical crops. She visited tea, coffee, quinquina, cocoa, tobacco, rubber, and sugarcane plantations and isolated parasitic organisms from these crops and also from rice, potato, and coconut. All of her isolations were later included in the CBS collection. At Sumatra she studied *Sclerotium rolfsii* as a parasite of tobacco. After her stay at Java, Dr. Westerdijk visited Japan. She has left a diary of this exciting period of her life, and it is enchanting to read her impressions of and experiences in this fascinating country.

Her hosts showed her many diseased crops and made a mycological collecting excursion with her. Unfortunately all material she gathered and her manuscripts were lost because war broke out. As she could not return directly to the Netherlands she continued her journey to the United States although the necessary funds could not reach her. She was able to earn her living by giving lectures at the various universities she visited. She established contacts everywhere in many widely separated states. Many of Dr. Westerdijk's pupils in the Netherlands have since been received not only with great hospitality but also as old friends in the United States when they showed an introductory letter from her. She enjoyed her stay immensely. Several American plant pathologists of the older generation still expressed their great admiration of Dr. Westerdijk some decades later. In her record of this trip in the Annual Report of her institute, she states that for a plant pathologist a journey through the United States is extremely instructive; some parasitic diseases there cause epidemics on a scale that is rarely seen in Europe.

In a letter to friends in Europe, Dr. Westerdijk commented on the peculiar position of a learned woman in the United States at that time. She attended a dinner party of scientific people, among whom there were only three women. "When leaving I was only a few steps away from the other two women when I was told to leave the building by the backdoor. I went and fell on an unlighted staircase. I met my company again outside the front door. Why did the women have to leave by the back door? Because people should not see women leave the building! Is the difference between front door and backdoor women not known in the USA? I had expected something different between the Golden Gate and the Statue of Liberty."

In 1917 Dr. Westerdijk was appointed professor in plant pathology at the State University of Utrecht, the first woman in such a prominent position in the Netherlands. In 1930 a second appointment followed at the University of Amsterdam at the request of her students. Now she had an enormous task as she had to give weekly lectures to students of both universities in addition to her responsibilities as director of the WCS and CBS foundations. Fortunately, she enjoyed excellent health and told us that she did not know what the word headache meant. Her practical courses in plant pathology became famous; in

1934 she even gave a course in Coimbra (Portugal) at the request of the university of that town.

Space soon became the limiting factor in the house at Amsterdam. In 1920 she was extremely happy to move to a mansion in the nearby village of Baarn, large enough to accommodate the rapidly extending culture collection, to house the many students who flocked there for practical training, and to provide living quarters for herself. Moreover, field experiments could be performed nearby in the new Botanical Garden of the State University of Utrecht. More and more biologists chose plant pathology as the subject of their study, attracted by Dr. Westerdijk's clear, well-prepared lectures, and scientific insight. The number of postgraduates working for a doctor's degree also increased steadily. The majority of them appeared between 1923 and 1940, when the prewar recession caused unemployment. What better to do than carry out experimental work leading to a doctor's degree? Her students carried out experiments on several diseases on which she had published short notes in the Annual Reports of the Phytopathological Laboratory in earlier years. The results are incorporated in 56 theses, covering a large number of plant diseases (7).

Dr. Westerdijk was well aware of the broad course phytopathology was taking as a science. It becomes clear from her ideas explained in her lectures and speeches that she played an important role in its development. For instance, in her inaugural lecture at Utrecht in 1917 (10), she emphasized the importance of knowledge of the physiology of both host and parasite. There she also expressed her longing for a textbook with symptoms of plant diseases arranged in groups. Two years later she and Professor O. Appel in Berlin published an extensive article on this subject (1). They proposed a system of plant diseases based on well-defined symptoms like anthracnose, canker, twig dieback, galls, etc. Up till then plant diseases had been grouped either by the taxonomy of the parasites or the host plants. The latter still seemed the best way for use in practice, but the new scientific system centered around the disease itself.

In the Utrecht lecture mentioned above, Dr. Westerdijk opposed the famous German phytopathologist Sorauer, who laid too much stress on predisposition to disease of host plants weakened by outer circumstances. Most of the fungi found on them would be only saprophytes, an opinion that she considered as insufficiently proven. Though she did not deny the influence of external conditions, she was convinced of the highly parasitic character of many fungi under most circumstances, and she stressed the importance of breeding resistant varieties as well as searching for the scientific base of resistance.

In her inaugural speech in Amsterdam in 1930 (11), she remarked that plant

pathology is not sufficiently rooted in other disciplines like soil science and biochemistry. Also, she said that the anatomy and the nutrient requirements of the crop plants have to be studied. Her words were those of a prophet.

During these years Johanna's personality came to its full development. Old friends, former assistants, and pupils still remember her creating the beneficial sphere of zest for work, of good cheer and joy for life, that made the time passed in the old mansion a happy period. Under guidance of this stimulating woman scientist, *homo ludens* had a good opportunity to work. She had her pronounced "no nonsense" opinions: A chosen study had to be finished in time; no thought about a holiday for a student in the midst of his experimental work. Expressions like "I am in doubt," "what a pity," or "I shall try, but perhaps . . ." did not exist in her vocabulary and were not tolerated in that of her pupils. She accepted unavoidable difficulties without remorse with an *es muss so sein* (it must be so). No wonder that her rather masculine behavior, together with her characteristic statements, provoked resentments sometimes. However, she had a warm heart, especially for young people, whom she helped as much as possible. As she herself had great courage and self-confidence to fulfill tasks that she found on her way, she tried to strengthen these qualities in her pupils: "Trust your possibilities and use them," she advised them. Her attitude toward students was more fatherly than motherly.

Regularly she invited the staff to her rooms to make music. She played the piano, the others sang. She was fond of festivities: "Working and feasting make fine spirits" was at her request carved in stone above the entrance of the room for practical work. Wherever she was, she showed equal interest in all the people she met, whoever they were, whether young or old, man or woman, active in religion or politics or not. Notwithstanding her straightforward reactions she was a fascinating, cheerful, and charming personality with a great sense of humor. This gave her an easy entrance to the bureaucracies of the world. Thus, during the period of unemployment before the Second World War she persuaded members of boards of foundations to allocate revenues for some young phytopathologists attacking urgent problems in the agricultural sector. Even a pathological problem in the oyster culture got attention and help. Many of Dr. Westerdijk's pupils found work in the practical field of plant pathology and industrial mycology in Europe, Indonesia, and elsewhere.

Over her whole life, Johanna Westerdijk's international relations were manyfold: a great number of foreigners worked in her laboratory and in the CBS. Of course the participants of the first International Phytopathological Congress held in 1923 at Wageningen paid a visit to Baarn. In 1938 she joined a group of 20 Dutch biologists on a visit to South Africa. Her command of

Dutch, German, French, English, and Spanish made her a highly appreciated president of international meetings. She became president of the International Federation of University Women (IFUW). During the years she served on the board of this institution she especially promoted scientific studies by awarding fellowships to women for studying in foreign countries. In 1937 she presided over the General Assembly of the IFUW at Krakow. The vote of thanks at the end of the Congress read "that she made the meeting so human and happy." This can be said of all meetings over which she presided, such as those of the Netherlands Phytopathological Society (of which she was President from 1945 to 1951). She used to call the meeting to attention by a clear "yodel" learned during her stay in Switzerland. Her life and personality are excellently described by her friend Maria Löhnis (6, 7).

Her outstanding leadership was recognized by the Dutch Government. She received the Royal Decoration of Knight in the Order of the Dutch Lion, was elected member of the Royal Netherlands Academy of Arts and Sciences and Fellow of the Linnean Society, was awarded honorary Doctor's degrees from the University of Uppsala (1957) and the Justus Liebig University in Giessen, Germany (1958); the Government of Portugal nominated her Knight of the Order of Santiago da Espada, and she was first to receive the Otto Appel Medal (established for outstanding plant pathologists) at Heidelberg in 1958. She was also an honorary member of many Dutch and foreign societies.

Dr. Westerdijk gave her last lecture in 1952, in a hall abundantly decorated with flowers where over 500 people were present to pay homage to their beloved professor and friend. On that occasion a Westerdijk fund for the advancement of plant pathology and mycology was established. Her South African admirers offered her a trip to their country, which she gladly accepted. Prominent plant pathologists made contributions to the Westerdijk issue of the *Tijdschrift over Plantenziekten* of which she had been coeditor for about 20 years. She passed away on November 15, 1961, at the age of 78 in her apartment in the laboratory, where she had lived for over 40 years.

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