PIONEERING WOMEN IN PLANT PATHOLOGY

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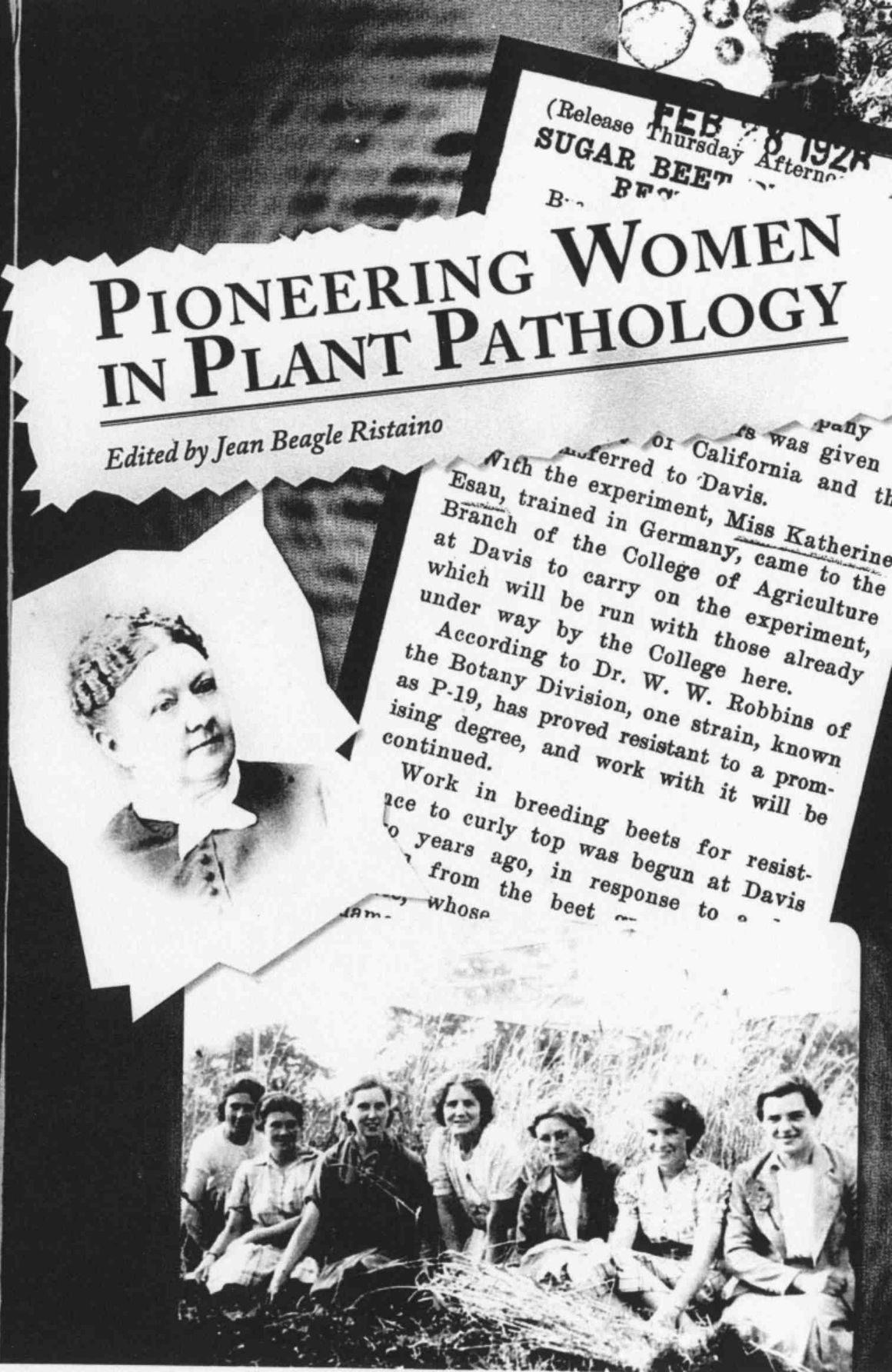

Mathilde Bensaúde

(1890–1969)

Portugal's Pioneer Plant Pathologist

Manuel M. Mota

". . . the farmers seem to take well to me and not mind my being a woman."
(Mathilde Bensaúde, 1920s, north of Portugal, during the seed potato campaign)

"To Mathilde Bensaúde, who by experimental and cytological investigations on a *Coprinus* species, first showed that heterothallism occurs in the Hymenomycetes."
(A. H. R. Buller, 1958 [14])

Mathilde Bensaúde, a pioneering woman plant pathologist from Portugal (17), lived an extraordinary life and made many significant contributions to the sciences of mycology and plant pathology. Two of her most important contributions were the discovery of heterothallism in the basidiomycetes—the primary scientific question of her 1918 doctoral thesis at the Sorbonne—and the establishment of the national Plant Quarantine Services (Serviços de Inspecção Fitopatológica) in Portugal in 1931. In addition, she also studied numerous fungi and bacteria and the diseases they cause, including Cladosporium *species on stone fruits,* Synchytrium endobioticum *(potato wart), and* Corynebacterium *(=* Clavibacter*)* sepedonicum *(potato ring rot). She produced the first report of* Olpidium *species on roots of several vegetable species in the United States and investigated rusts (Uredinales) from citrus groves in southern Portugal's region of Algarve. She also studied and established control measures, including pioneering biological control methods (such as the use of* Rodolia cardinalis, Cryptolaemus montrouzieri, *and* Aphelinus mali*), for several insect pests, such as* Sphinx convolvuli *on sweet potato,* Unaspis *(=* Chionaspis*)* citri *on citrus,* Phthorimaea operculella *on orange,* Aspidiotus perniciosus, Ceratitis capitata *(Mediterranean fruit fly), and fire ants, among others. Early in her career, beginning in 1912, Bensaúde forged strong scientific ties with the United States, particularly*

with the Department of Plant Pathology at the University of Wisconsin-Madison. Her contributions to plant pathology and her visits to Madison have been honored with a plaque still on display in the department.

Mathilde Simone Rachel Pauline Bensaúde, born on January 23, 1890, was a daughter of Alfredo Bensaúde, a wealthy engineer and founder of the Instituto Superior Técnico (School of Engineering) at the University of Lisbon, and a Jewish Frenchwoman, Jane Gabrielle Eleonore Oulman. The Bensaúdes were a well-known traditional and wealthy family from the Island of São Miguel, Azores, with strong economic interests in the export of agricultural products, such as pineapple, to the United States. The educational and cultural milieu in which Bensaúde grew up in Lisbon was thus very rich, and the family house in the sophisticated Lapa neighborhood was a place of frequent gathering for illustrious writers, architects, and musicians in early twentieth-century Lisbon.

Bensaúde's scholarly education, encouraged greatly by her grandfather José Bensaúde, was completed chiefly in Germany and then in Switzerland, shortly before World War I, at the Ecole de Morges, near Lausanne and at Lausanne University (1909). There, she completed her first classes in the physical and natural sciences. In 1913, following a short visit to Lisbon, she conducted some laboratory work and took courses in protozoology with a German specialist, H. Fahrenholz, who was working in 1913 at the Câmara Pestana Bacteriological Institute (a well-known bacteriological institute in Lisbon). In fact, at this time, she had her mind set on being a protozoologist. Certainly, her contact with Carlos França, the greatest Portuguese protozoologist of the time, influenced her intent. França was also working at the Câmara Pestana Bacteriological Institute; however, Bensaúde's contact with him was occasional and did not involve joint research. Later that year, Bensaúde went to the Sorbonne in Paris, where she earned "certificats" in zoology, histology, embryology, and evolution, under M. Caullery, a specialist in bryozoans. In Paris, Bensaúde also met a Canadian colleague, William Thompson, who later became a renowned entomologist. Thompson introduced her to David Keilin, a fellow student who became an accomplished embryologist. Having been advised to obtain some practical experience through actual laboratory work, Bensaúde pursued courses in nervous system histology with Jean Nageotte and in marine biology and plankton with Prof. Perez. As a result, Bensaúde's education was well-rounded and covered a variety of subjects.

The outbreak of World War I interrupted Bensaúde's studies because her father—ever her protector—ordered her return to Lisbon in 1914. Finally, after her eloquent pleading, her father conceded and allowed her to return to Paris in 1915 to complete her higher education. Alfredo Bensaúde had just been put in charge of creating the first higher education school for engineering (the Instituto Superior Técnico) by the recently established Republican Government in Lisbon. The letters to her father reflect her anxiety for

this separation, and she often pleaded for her father to leave the institute and come visit her in Paris. Her father and grandfather were highly instrumental and important in her scientific education. She dedicated her doctoral thesis to her grandfather. However, her mother was her spiritual and moral beacon. Her notes indicate that upon her return she found Paris different, and she became bored with protozoology. Bensaúde then decided to move on to botany, studying with L. Matruchot, an excellent mycologist and educator. She finally completed her degree requirements at the Sorbonne in 1916, in the middle of World War I. Communication was difficult, and there were few scientific publications and little contact between France and Germany. This situation may account for the overlap of her research and that of several German mycologists, such as Hans Kniep, although she cites his research on *Hypochnus terrestris* (an autobasidiomycete) in her own doctoral thesis.

Bensaúde immediately and enthusiastically pursued her studies on fungi at the doctoral level. Her research proposal was a study of the poorly understood cytology of the basidiomycete mycelium, particularly in its binucleate stage, the origin of which was practically unknown at the time. She published a short note on her studies in 1917; this paper, entitled "Sur la sexualité chez les champignons Basidiomycêtes" ("Sexuality in the Basidiomycete fungi"), appeared in *Comptes Rendus Hebdomadaire des Séances de l'Académie des Sciences* (1). Bensaúde's doctoral thesis, "Recherches sur le cycle évolutif et la sexualité des Basidiomycêtes" ("Research on the evolutionary cycle and sexuality of Basidiomycetes") (2), elaborated further upon this research. At this time, it was thought that there were no sexual organs in this group, although both uninucleate and binucleate mycelia—with the formation of a dikaryon—were recognized, and several of Bensaúde's predecessors conducted extensive research on the cytology and ontogeny of the dikaryon stage. Among them were Alfred Blakeslee, who in 1904 discovered heterothallism in isogamic species of the order Mucorales and introduced +/– terminology; V. H. Blackman, who in 1904 worked on the order Uredinales; and Kniep, who in 1913 worked on *Hypochnus terrestris*. Kniep demonstrated, and as Bensaúde's citation acknowledges, chromatic reduction and the consequent formation of four haploid nuclei following karyogamy.

Bensaúde's thesis contributed with three main concepts to this research area: (i) the role of clamp connections in conjugated divisions and their significance in the diagnosis of secondary mycelia; (ii) the establishment of the homology of the "hooks" (from ascogenous hyphae of ascomycetes) and "clamp connections" (from secondary mycelia of basidiomycetes), thus clarifying a confusing terminology, even though recognizing that Kniep had already established this homology; and (iii) the concept of heterothallism in autobasidiomycetes, using *Coprinus fimetarius* cultures. Kniep reached a similar conclusion later in 1920, ignoring Bensaúde's work, which is understandable since French books and scientific journals were not allowed in Germany during the war. These fundamental concepts were sufficient to

place her among the top mycologists of the time, as Kniep (1922) and Buller (1958) later acknowledged (14).

In 1919, after World War I, Bensaúde went to the United States for the first time. She arrived in New York City, where she collaborated with Roland Harper and became the assistant to the Mycological Herbarium of the Brooklyn Botanical Gardens. It is possible that one motivation for this trip was the family's economic and commercial interests in this city, in which her brother was their representative, although there are no testimonies or written statements concerning her intent. In 1921, Bensaúde arrived in Madison for the first of her three visits to the University of Wisconsin (Figs. 1 and 2). Despite being a post-doc, she completed several courses in the Plant Pathology Department, headed by the famous L. R. Jones, and met illustrious colleagues, including J. C. Walker, A. J. Riker, and F. R. Jones. In 1922, she coauthored with G. W. Keitt a short note on experimental inoculations with different *Cladosporium* species and stains on fruit trees. She also collaborated with Keitt on the first report of *Olpidium* species (specifically *O. brassicae*) parasitizing the roots of tomato, tobacco, and cabbage, published in 1923 (3), and on a second, more detailed paper on several species of the genus *Cladosporium* in 1928 (12,13). In this paper, Bensaúde and Keitt concluded that two major *Cladosporium* groups must be considered: one that parasitized peach trees and the other, wild cherry. Bensaúde left Madison in 1923 to return to the island of São Miguel (St. Michael), Azores, to help with the family business and become a plant pathology consultant for the brokerage society that handled the St. Michael pineapple export (Fig. 3). Between 1923 and 1928, she traveled a few times to England, where E. J. Butler at the Mycological Herbarium at the Royal Botanic Gar-

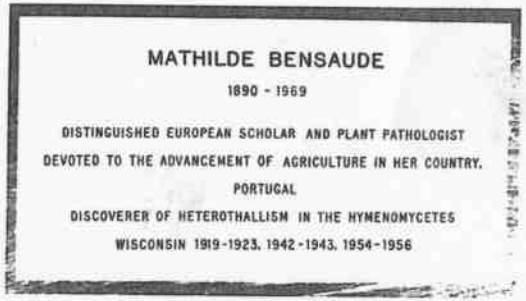

Figure 1. Plaque in Mathilde Bensaúde's honor on display in the Plant Pathology Library at the University of Wisconsin-Madison. (Courtesy Maria de Lourdes Borges)

Figure 2. Mathilde Bensaúde on her first visit to the Department of Plant Pathology at the University of Wisconsin-Madison. Bensaúde is in the first row, fourth from the left. (Reproduced with permission of the University of Wisconsin Archives)

Figure 3. Mathilde Bensaúde reading at her desk, circa 1920–1930. (Courtesy Maria de Lourdes Borges)

dens at Kew (Fig. 4) and W. F. Bewley at Cheshunt were particularly helpful. While in the Azores, Bensaúde published a list of pests and pathogens associated with several local crops, such as pineapple, potato, garlic, onion, melon, peanut, and banana (5). Her scientific expertise was pivotal in developing control methods, which would later be useful, when she was called upon by the Ministry of Agriculture in Lisbon to establish the Plant Quarantine Services. For example, she promoted the use of arsenic mixtures to control *Sphinx convolvuli*, an important sweet potato pest, and of sulfuric mixtures to control *Unaspis* (= *Chionaspis*) *citri*—methods that were quite remarkable at the time. Another important pest control measure Bensaúde developed was the postharvest control of *Phthorimaea operculella* on seed potato. Also, in 1925, Bensaúde published a paper reviewing work on plant-parasitic protozoa (4), including the work by França.

In 1928, Bensaúde accepted a post at the Instituto Rocha Cabral, a biological sciences research center in Lisbon, and began her collaboration with the Estação Agrária Nacional (today the Estação Agronómica Nacional, or the Agricultural Research Station). She published several interesting publications during this period, namely one on a *Phytophthora* species parasitizing citrus (7), previously discovered in 1925 by Moniz da Maia; a major compilation of wheat diseases and their distribution in Portugal, including

Figure 4. Mathilde Bensaúde (lower left front row) on the front steps of the International Mycological Institute at the Royal Botanic Gardens, Kew, England, circa 1923–1928, with J. Westerdijk (back row, left) (see page 155), Dr. and Mrs. Drechsler (back and front row, center), E. J. Buller, and Laslo Weslin. (Courtesy Maria de Lourdes Borges)

seed treatment recommendations (6); a short note on *Cochliobolus spicifer* (= *Helminthosporium tetramera*) parasitizing wheat from Angola (8); and, in collaboration with Gonçalves da Cunha, a study of a *Pythium* species parasitizing rice (15).

In 1931, Bensaúde was officially invited to organize the Plant Quarantine Services in Portugal (Serviços de Inspecção Fitopatológica). This was a major turning point in her career and her first post as a civil servant. She was 40 years old at the time. During her 9 years there, she collided with organizational bureaucracy and inefficiency, something utterly counter to her way of life. During the process of establishing the Plant Quarantine Services, Bensaúde became tired of the foot-dragging by ministries involved. She decided to approach the prime minister, Antonio Salazar, in a most peculiar way. She found out the time his train was traveling between Lisbon and Santa Comba Dao, eluded a guard's attention, and sat directly in front of his seat. She personally urged him to speed up the process. Indeed, it worked.

At the Plant Quarantine Service, Bensaúde continued some research she had begun in 1929. At that time, she had detected several foci of potato wart, *Synchytrium endobioticum*, in northern Portugal, in the vicinity of Montalegre and Chaves, two major potato-growing regions. Her immediate, decisive actions and recommendations regarding the sanitation and isolation of pathogen-infested areas became pivotal in controlling the disease. A pamphlet she authored particularly for farmers detailed clear, practical measures. Early during the campaigns to establish clean seed in northeastern Portugal, the local population would ring the church bells to announce her arrival in grim terms since she was often the bearer of bad news as to the quality of the potatoes (especially black wart disease). However, after realizing her effort to help the people better their lives, their attitudes changed radically, and she became welcome.

Although already in charge of the Plant Quarantine Services, Bensaúde took responsibility for gathering potatoes from infested areas and selling them to the military units in Porto. A certain amount of money was thus obtained. The remaining funds necessary to obtain and distribute new, clean seed potato should have come from the state. However, not wanting to see disaster and poverty strike the local farmers, Bensaúde obtained the necessary funding, 80,000 escudos (one could buy a very large house with this amount, in those days!) from her father, who made her promise she would resign her post the following day. During her 9 years as head of the Plant Quarantine Service, Bensaúde implemented a series of regulations that were crucial to establishing good sanitation measures for potato as well as for many other crops. Her activities in the extension department, including the publication of numerous leaflets on all sorts of plant diseases and pests, were also very important (11).

At the age of 50, tired of the Portuguese bureaucracy, Bensaúde was ready to move on with her career and renewed her research. She took two additional trips to Madison, Wisconsin, 1942–1943 and 1954–1956, com-

menting that "the blissful happiness of the city . . . is like an oasis to me" (16). One of her major interests then became ring rot of potato, caused by *Corynebacterium* (=*Clavibacter*) *sepedonicum*. One of the main issues concerning this disease, which she clarified in 1946, was that wilting results not from the clogging of xylem vessels, as previously thought, but from the digestion of the middle lamella of nonlignified parenchyma cells (9,10).

One of Bensaúde's later contributions was to help establish the internationally known coffee rust center in Oeiras, directed by Branquinho da Fonseca. From 1941 to 1969, Bensaúde was a visiting scientist at the Estação Agronómica Nacional. Because coffee is not grown in Portugal, because of latitude and temperature, it is relatively easy to maintain populations and strains of rusts (*Hemileia vastatrix*) in coffee plants there, without the risk of spreading the disease to a commercial crop.

Bensaúde was married for a time in 1935. It was said to be a "marriage of convenience". She married a German Jew and helped him to legally leave Nazi Germany. He was 10 years younger than Bensaúde. They married in the almond orchards of Algarve. Every year, on the anniversary of their wedding, he sent her a bouquet of flowers.

Mathilde Bensaúde died on November 22, 1969. Her contributions have remained a landmark in the early history of Portuguese and international plant pathology and mycology (14), and she certainly deserves a special place as a pioneering woman in plant pathology.

Acknowledgments

I would like to thank Orson K. Miller, outstanding mycologist, who, at Virginia Tech in 1987, introduced me to the wonders and mysteries of mushrooms and, together with his wife Hope, to their culinary variety. Maria de Lourdes Borges (see page 179) and Fernanda Henriques (granddaughter of Mathilde Bensaúde) provided biographical information for this chapter.

Literature Cited

1. Bensaude, M. 1917. Sur la sexualité chez les champignons Basidiomycêtes. C. R. Hebd. Séances Acad. Sci. 165:286-288.
2. Bensaude, M. 1918. Recherches sur le cycle évolutif et la sexualité des Basidiomycêtes. Doctoral thesis. Université de Paris, Sorbonne. Imprimerie Nemourienne, Nemours, France.
3. Bensaude, M. 1923. A species of *Olpidium* parasitic in the roots of tomato, tobacco and cabbage. Phytopathology 13:451-454.
4. Bensaude, M. 1925. Flagellates in plants: A review of foreign literature. Phytopathology 15:273-281.
5. Bensaude, M. 1926. Diseases of economic plants in the Azores. Bull. Misc. Inf. R. Bot. Gard. 7:381-388.
6. Bensaude, M. 1929. Notes on wheat diseases in Portugal. Bol. Soc. Brot. Ser. 2 6:1-42.

7. Bensaude, M. 1929. Notes sur la *Phytophthora*, parasite des Citrus au Portugal. Compt. Rend. Séances Soc. Biol. (Soc. Port. Biol.) 101:982-984.
8. Bensaude, M. 1930. L'*Helminthosporium tetramera* McK. Sur blé à Angola. Compt. Rend. Séances Soc. Biol. (Soc. Port. Biol.) 103:1265-1266.
9. Bensaude, M. 1946. Rapport entre la distribution des bactéries et la fletrissure, dans des plantes parasitées par le *Corynebacterium sepedonicum*. Bol. Soc. Brot. Ser. 2 20:1-14.
10. Bensaude, M. 1946. Multiplication et migration du *Corynebacterium sepedonicum* dans les tissues des plantes infectées. Bol. Soc. Brot. Ser. 2 20:17-31.
11. Bensaude, M. 1957-1958. Leis e batatas. Naturalia 7:1-37.
12. Bensaude, M., and Keitt, G. W. 1922. A preliminary report on cross-inoculation experiments with strains of *Cladosporium* from stone fruits. (Abstr.) Phytopathology 12:46.
13. Bensaude, M., and Keitt, G. W. 1928. Comparative studies of certain *Cladosporium* diseases of stone fruits. Phytopathology 18:313-329.
14. Buller, A. H. R. 1958. Researches on Fungi, Vol. IV. Hafner Publishing Co. New York.
15. Gonçalves da Cunha, A., and Bensaude, M. 1934. Sur l'existence d'une Pythiacée sur le riz au Portugal. Compt. Rend. Séances Soc. Biol. (Soc. Port. Biol.) 117:733-734.
16. Jones, E. S. 1972. Mathilde Bensaude, 1890–1969. Phytopathology 62:1229.
17. Quintanilha, A. 1971. Mathilde Bensaude. Bol. Soc. Port. Ciênc. Nat. 13:5-19.