

ACKNOWLEDGMENTS

I thank Mr. Ken Marr for bringing *Puccinia rugispora* to my attention, Dr. Joe F. Hennen for observations of the material and suggestions for the manuscript, and Dr. Harold St. John for the Latin descriptions.

Key Words: Hawaiian rusts, Rutaceae

LITERATURE CITED

Arthur, J. C. 1962. *Manual of the Rusts in United States and Canada*. Hafner Publishing Co., New York. 438 p.

Cummins, G. B. 1941. Uredinales of New Guinea—IV. *Mycologia* 33: 380–389.

—. 1949. New species of *Puccinia* on Lauraceae from China. *Bull. Torr. Bot. Club* 76: 31–38.

—. 1953. The species of *Puccinia* parasitic on the Andropogoneae. *Urediniana* 4: 5–90.

—. 1971. *The Rust Fungi of Cereals, Grasses and Bamboos*. Springer-Verlag, New York. 570 p.

Doidge, E. M. 1927. A preliminary study of the South African rust fungi. *Bothalia* 2: 1–228.

Gardner, D. E., and C. S. Hodges, Jr. 1989. The rust fungi (Uredinales) of Hawaii. *Pacific Sci.* 43: 41–55.

Hennen, J. F., M. M. Hennen, and M. B. Figueiredo. 1982. *Index of the Rust Fungi (Uredinales) of Brazil*. Arquivos Instituto do Biológico, São Paulo. 201 p.

Hennings, P. 1896. Beiträge zur Pilzflora Sudamerikas I. *Hedwigia* 35: 202–262.

Neal, M. C. 1965. In *Gardens of Hawaii*. Special Publ. No. 50, Bernice P. Bishop Mus. Press, Honolulu. 924 p.

Saccardo, P. A. 1888. *Sylloge fungorum*. Vol. 7, p. 841.

—. 1895. *Sylloge fungorum*. Vol. 11, p. 215.

—. 1912. *Sylloge fungorum*. Vol. 21, p. 589.

—. 1925. *Sylloge fungorum*. Vol. 23, Pp. 772–773, 909–910, 946.

Mycologia, 82(1), 1990, pp. 144–147.

© 1990, by The New York Botanical Garden, Bronx, NY 10458-5126

MARGARET B. CHURCH, 1889–1976

C. W. HESSELTINE

5407 Isabell, Peoria, Illinois 61614

Dr. Margaret Brooks Church was a distinguished mycologist and a charter member of the Mycological Society who has been neglected in the history of mycology. She made several noteworthy contributions to systematic and applied mycology. She, along with Dr. Charles Thom, wrote the first manual on the genus *Aspergillus*. The first authoritative treatment of oriental fermented foods in the West was written by her. It remains an accurate account of these fermentation processes. Dr. Church also conducted laboratory experiments on soy fermentations and collaborated with Japanese workers, especially Professor K. Oshima; Hokkaido Imperial University, Sapporo, Japan.

The mold fermentations naturally led Dr. Church to studies of industrial mold enzymes in the early 1920s. She was the first western person to study the ang-khak fermentation based upon the molding of rice with certain strains of *Monascus* to produce a red pigment used in food coloring.

Dr. Church was born in Providence, Rhode Island, on March 13, 1889. She received an A.B. in 1912, an A.M. in 1914, and a Ph.D. in 1918, all from Brown University. Her majors were in botany and zoology. She had extensive training in languages including seven years of French, six years of Latin and one year of Greek. She could also translate German and Scandinavian languages. This background served as good training in her work as an abstractor and indexer for Biological Abstracts.

Her first position was as a "collaborator in forest pathology" with the USDA. This involved the indexing of the literature on fungus disease of trees, especially chestnut blight. In September, 1915, she was appointed as a "Microanalyst," and in 1916, she was appointed "Assistant Mycologist" in the group headed by Dr. Charles Thom. With Thom she studied the genus *Aspergillus*, and, together, they published a monograph on this genus that still forms the basis for all subsequent taxonomic work on the genus. She



Margaret B. Church

also assisted Thom with his first monograph of the genus *Penicillium*.

Dr. Church was involved in establishing a permanent collection of fungus cultures which was the beginning of the ARS Culture Collection at the Northern Regional Research Center in Peoria, Illinois. She must have shared some of Thom's feisty personality. Dr. Thom, in his ad-

dress to the Mycological Society, relates how a large collection of *Fusarium* strains was sent to Church for incorporation into the fungus collection. All of the agar slants were infested with fungus mites. She promptly put the tubes back in a box and sent them post haste back to the depositor.

One of Dr. Church's duties was to examine

spoilage-causing fungi and to maintain the fungus portion of the American Type Culture Collection. She studied extensively the spoilage of high-sugar products by microorganisms. I was surprised to find that she and John S. Buckley of the Pathology Division of Animal Industry, USDA, studied the effect of feeding molds to rats; and although many strains tested did not harm the animals, in some instances the rats died after being fed certain strains of *Aspergillus* and *Penicillium*. Many *A. flavus* strains were not toxic, but a few were highly toxic and killed the rats.

One of her most important contributions was the USDA Department Bulletin 1152 entitled, "Soy and Related Fermentations," published in 1923. At that time there was interest in establishing soybean production in the United States because soybeans were being imported into the U.S. from the Orient. This publication had many photographs of the industrial processes of making koji and soy sauce in Japan. Research in soy sauce production began in 1918 and continued for several years. Soy sauce, miso, molded tofu, and natto were also described. A second paper dealt with the red rice fermentation carried out by *Monascus*. Professor T. Takahashi of the University of Tokyo spent one month in Washington, D.C., working with Dr. Church.

Dr. Church's research dealt extensively with koji, and it is surprising that she knew even then that tane koji (koji inoculum) consisted of several selected mold strains of *Aspergillus oryzae*. The fact that yellow-green *Aspergillus* strains were employed in these fermentations undoubtedly led both Thom and Church to publish the taxonomic relationships of this group of molds in 1921. Her research on koji was a likely catalyst for her study of industrial enzymes.

In 1928, she resigned as assistant mycologist from USDA at the princely salary of \$3700 per year and was later replaced by Dr. Kenneth Raper. She joined the faculty of Urbana University, Urbana, Ohio, and became head of the Biology Department. After leaving government service she published no research, as the focus of her career was teaching biology.

In 1938-1939, Dr. Church served as an indexer and abstractor for Biological Abstracts. Upon her retirement, presumably in 1939, she moved to Lyndon, Vermont. Her last days were spent with her sister at Pawtucket, Rhode Island. In a letter written by Dr. Thom, he indicates Margaret had some nerve problems and that she

was subject to sporadic bouts of acute facial pain. Perhaps this was the reason for her early retirement.

In Lyndon, Margaret Church was remembered by several people for her interest in teaching children and her gift of instilling enthusiasm for the study of living things. She died December 31, 1976, in Cranston, Rhode Island. The sister with whom she lived was the only family known to Margaret.

I became interested in this pioneering woman scientist in 1985 when I was preparing the annual lecture for the Mycological Society. I could find pictures and accounts of Japanese pioneers in soybean fermentations, but could find no biographical information about Dr. Church or what she had done. For the last three to four years I have been tracking down information about this American pioneer in the study of oriental fermentations who was instrumental in establishing the classification of industrial molds.

ACKNOWLEDGMENTS

I would like to acknowledge the help of many people who have contributed information. I am especially indebted to Dr. Clark Rogerson and to Dr. Ruth Gordon. I also thank Dr. D. Wicklow for reviewing the manuscript.

Key Words: Margaret Church, koji, *Aspergillus*, fermented foods

PUBLICATIONS BY MARGARET CHURCH

1. Church, M. B. 1916. The development of the embryo sac and embryo of *Cooperia drummondii*. *Bull. Torrey Bot. Club* **43**: 397-405.
2. —. 1918. Colloidin-paraffin methods. *Science* **47**: 640.
3. —. 1919. The development and structure of the bulb in *Cooperia drummondii*. *Bull. Torrey Bot. Club* **46**: 337-362.
4. —. 1919. Root contraction. *Plant World* **22**: 337-340.
5. —. 1920. Laboratory experiments on the manufacture of Chinese Ang-khak in the United States. *J. Indust. Eng. Chem.* **12**: 45-46.
6. —. 1921. Bacteria in cane sugar products. *Sugar* **23**: 413-414, 491-492.
7. —. 1921. The relation of mosaic disease to pickling of cucumbers. *Phytopathology* **11**: 28-29.
8. —. 1923. Soy and related fermentations. *U.S.D.A. Dept. Bull.* **1152**: 1-26.
9. —. 1928. *Phytophthora*, *Pythium* and *Pythiacystis* species as stock cultures. *Phytopathology* **18**: 247-248.
10. —. 1931. The sugar tolerance of yeasts expressed in atmospheres. *Science* **74**: 492-493.
11. —, and J. S. Buckley. 1923. Laboratory feed-

ing of molds to animals. *North American Veterinarian* **4**: 7-12, 15.

12. —, and J. Hamilton. 1926. Microorganisms in the manufacture of confectionery. *Manuf. Confectioner* **6**: 28-31.

14. —, and C. Thom. 1921. Mold hyphae in sugar and soil compared with root hairs. *Science* **54**: 470-471.

15. May, O. E., H. T. Herrick, C. Thom, and M. B. Church. 1927. The production of gluconic acid by the *Penicillium luteum-purpurogenum*, Group I. *J. Biol. Chem.* **75**: 417-422.

16. Oshima, K., and M. B. Church. 1923. Industrial mold enzymes. *J. Indust. Eng. Chem* **15**: 67-70.

17. Thom, C. 1930. *The Penicillia*. Williams & Wilkins, 644 pp. [With the assistance of Dr. M. B. Church in handling cultures.]

18. —, and M. B. Church. 1918. *Aspergillus fumigatus*, *A. nidulans*, *A. terreus*, n. sp. and their allies. *Amer. J. Bot.* **5**: 84-104.

19. —, and M. B. Church. 1921. *Aspergillus flavus*, *A. oryzae* and associated species. *Amer. J. Bot.* **8**: 103-126.

20. —, and M. B. Church. 1926. *The Aspergilli*. Williams & Wilkins Co., Baltimore, 272 pp.
