Plant Pathology
COLLEGE OF AGRICULTURAL & LIFE SCIENCES
UNIVERSITY OF WISCONSIN–MADISON

History Note No. 5

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History Note No. 5 – USDA/ARS Pioneering Research Lab, Plant Disease Resistance Research Unit - 1964-2003. Part A - The First Four Scientists/Faculty Members

In the early 1960s, Prof. G. S. Pound believed that the time had come for an all-out research effort on the physiology and biochemistry of plant disease resistance. Pound was well connected with administrators in the Agricultural Research Service (ARS) and used his persuasive manner to secure the establishment of a "Pioneering Research Laboratory" in the Department of Plant Pathology in 1964. Dr. Richard Durbin was appointed research leader of this new ARS unit called the Plant Disease Resistance Unit. Durbin was already on site as an ARS oat pathologist focusing on *Septoria* stem and leaf blotch and had started a program in disease physiology. Four scientists with faculty appointments would form this unit: a plant pathologist/disease physiologist (Durbin), a biochemist (Upper), a plant physiologist (Helgeson) and a microbiologist (Kemp). Each position was well-funded with support for equipment and a technician. Pound believed it was important that these scientists have faculty appointments so that they could mentor students and participate in faculty governance. This ARS unit would have offices and labs on the 6th and 7th floor of the newly constructed Russell Laboratories.

This unit was renamed in 1973 as the Plant Disease Resistance Research Unit (PDRRU) and remained as such until the retirement of Dr. J. Helgeson in 2003. The ARS scientists had many collaborative research efforts with faculty in Plant Pathology and other departments. A few of the numerous achievements of the first group of scientists in this ARS unit are highlighted in the following paragraphs.

Dr. Richard D. Durbin (1962-1990). Durbin and his team were recognized worldwide for their research on the role of preformed host metabolites on pathogen specificity and the molecular specificity and mode of action of chlorosis-producing phytotoxins. The structure of tabtoxin produced by *Pseudomonas coronafaciens* was shown to be tabtoxinine beta lactam, and its mode of action involved the inhibition of host glutamine synthetase, which leads to the chlorotic symptom. Additionally, the phytotoxin, tagetitoxin, produced by *Pseudomonas tagetis* was found to be an inhibitor of chloroplast RNA polymerase.

References:

Durbin, R.D. 1991. Bacterial Phytotoxins. Experientia 47:776-783.

Mathews, D.E. and R.D. Durbin. 1990. Tagetitoxin inhibits RNA synthesis directed by RNA polymerases from chloroplasts and *Escherichia coli*. J. Biol. Chem. 265:493-498.

Thomas, M.D., P.J. Langston-Unkefer, T.F. Uchytil, and R.D. Durbin. Inhibition of glutamine synthetase from pea by tabtoxinine-ß-lactam. Plant Physiol. 71:912-915.

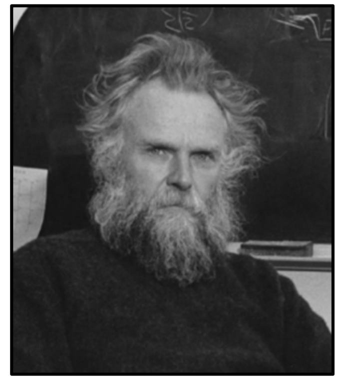
Dr. John P. Helgeson (1966-2003). Helgeson's research program focused on plant tissue and cell culture as a model for studying plant diseases. This included the isolation and cultivation of individual leaf cells and regeneration of new plants from single cells. These cells were used in somatic hybridization of different plant species as a means for introducing new disease resistances enabling the genetic analysis of disease resistances of the new somatic hybrid plants. Ultimately, they mapped, isolated and characterized a gene from a somatic hybrid between potato, *Solanum tuberosum*, and *Solanum bulbocastanum* that gives resistance to late blight of potato. In addition, Helgeson took study leaves in England and France and hosted a number of visitors from France, Brazil, the Netherlands, Germany, Hungary and Mexico. He led a research cooperation program with Germany and participated in tests of late blight resistances in Toluca, Mexico.

References:

Helgeson, J.P., J.D. Pohlman, S. Austin, G.T. Haberlach, S.M. Wielgus, D. Ronis, L. Zambolim, P. Tooley, J.M. McGrath, R.V. James, and W.R. Stevenson. 1998. Somatic hybrids between *Solanum bulbocastanum* and potato: a new source of resistance to late blight. Theor. Appl. Genet. 96:738-742.

Song, J., J.M. Bradeen, S.K. Naess, J.A. Raasch, S.M. Wielgus, G.T. Haberlach, J. Liu, H. Kuang, S. Austin-Phillips, C.R. Buell, J.P. Helgeson, and J. Jiang. 2003. Gene RB cloned from *Solanum bulbcastanum* confers broad-spectrum resistance to potato late blight. PNAS 100:9128-9133.

Dr. Christen D. Upper (1966-2001). Upper and his colleagues, mainly Dr. Susan Hirano and S. Lindow (a graduate student), are best known for the discovery of the role of epiphytic ice nucleation-active bacteria in frost injury to plants. This research had its beginning when Drs. D. C. Arny and Upper were attempting to understand the increased frost sensitivity of corn seedlings that had been inoculated with dried and powdered corn leaves infected with *Setosphaeria turcica.* This had been first observed by Paul E. Hoppe (USDA Scientist) and Arny in early 1960s. The Upper team showed that this increased sensitivity was the result of the naturally present ice nucleation-active bacterium, *Pseudomonas syringae,* and not *S. turcica*. Upper's team then went on to establish the quantitative foundation for phyllosphere ecology, and quantitative models were able to related large population sizes of *P. syringae* pv. *syringae* on individual bean leaves to disease outbreaks. Early research on the expression of a resistance gene in tobacco tissue culture was done by Upper in collaboration with J. Helgeson.



Reference:

Arny, D.C., S.E. Lindow and C.D. Upper. 1976. Frost sensitivity of *Zea mays* increased by application of *Pseudomonas syringae*. Nature 262:282-284.

Hirano, S.S. and C.D. Upper. 1990. Population biology and epidemiology of *Pseudomonas syringae*. Annu. Rev. Phytopathol. 28:155-177.

Hirano, S.S. and C.D. Upper. 2000. Bacteria in the leaf ecosystem with emphasis on *Pseudomonas syringae* – pathogen, ice nucleus, and epiphyte. Microbiol. and Molecular Biol. Rev. 64:624-653.

Hoppe, P.E., D.C. Arny, and J.W. Martens.1964. Frost susceptibility in corn increased by leaf blight infections. Plant Dis. Reptr. 48:815-816.

Dr. John D. Kemp (1968-1981). Kemp's early research involved evaluation of plant tissue culture to study disease resistance. He then transitioned to measuring protein synthesis and degradation in tissue cultures. In the mid 1970s, his lab started the study of the Ti (tumor-inducing) plasmid from *Agrobacterium tumefaciens*, and this led to characterizations of octopine, histopine, and nopaline biosynthesis in plant tissue culture. His research team then focused on developing a modified Ti plasmid that could be used in genetic engineering plants for gene expression. Kemp's team along with Timothy C. Hall's team in the Horticulture Department were the first to show the integration of a plant gene (phaseolin from bean) into a chromosome of a taxonomically unrelated plant, the sunflower, and the gene's expression. This transformed plant, callus tissue, was called the "sunbean". This groundbreaking research was one of the first successful efforts to improve plants by genetic engineering. Kemp and Hall left UW-Madison in 1981 to join Agrigenetics Advanced Research Laboratory, Madison, WI.

Bruce Fritz

Photo of John D. Kemp from Newsweek, Aug 1981. The plant shown has NOT been transformed.

References:

Gurley, W.B., J.D. Kemp, M.J. Albert, D.W. Sutton, and J. Callis. 1979. Transcription of Ti plasmid-derived sequences in three octopin-type crown gall tumor lines. PNAS 76:2828-2832.

Murai, N., D.W. Sutton, M.G. Murray, J.L. Slightom, D.J. Merlo, N.A. Reichert, C. Sengupta-Gopalan, C.A. Stock, R.F. Barker, J.D. Kemp, and T.C. Hall. 1983. Phaseolin gene from bean is expressed after transfer to sunflower via tumor-inducing plasmid vector. Science 222:476-482.

Kemp_New York Times. June 30, section C, pg 4. Protein gene is transplanted from bean to sunflower.

Kemp_Newsweek, Aug 10, issue, 1981, pg 74-75.

Kemp_Plaque: History of Genetics at the Smithsonian Museum, Washington, DC. "First plant-plant gene transfer."

Kemp_Wisconsin State Journal. 1981. Jun 30, pg 2. Plant scientists create 'Sunbean'.

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